SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY, 1930.

GENERAL PHYSICS.

2376. Diophantine Quantities. E. W. Washburn. *Bureau of Standards, J. of Research,* 4. *pp.* 221–246, *Feb.,* 1930.

A diophantine quantity is defined as a quantity which is numerically conditioned in such a way that it is a member of a set of known quantities. The measurement of such a quantity in the laboratory is, therefore, a problem of identification. The principles of measurement and of calculation and the precision aspects of measurements involving one or more diophantine quantities present features quite different from those associated with ordinary physical measurements. In particular, the individual determinations should not be averaged, and the most favourable experimental values are not necessarily those which are closest to the true value. The principles of " precision of measurement " as set forth in the numerous treatises on that subject are not applicable to the measurement of diophantine quantities, and may lead to erroneous conclusions. In the present paper an experimental procedure for measuring such quantities is described, and appropriate methods for treating the experimental data are developed. The treatment of the subject is based upon the " principle of maximum error" and the methods of diophantine analysis instead of the theory of probability and the calculus. Examples of diophantine problems in chemistry and physics are given. AUTHOR.

2377. Determination of Parameters in an Empirical Formula. W. E. Deming. *Phys. Soc., Proc.* 42. *pp.* 97–107, *Feb.* 15, 1930.

The writer reviews the method of least squares and gives reasons for recalling some cautions regarding its use that were mentioned by Stewart and Uhler several years ago. Examples are worked out to illustrate the discussion. The method recently mentioned by Awbery [see Abstract 3468 (1929)] is compared with those of least squares and zero sum, from the practical point of view. Judging from the few examples given, the method of zero sum appears to be the quickest and its results to be well in accord with common-sense judgment. The amount of computation involved in the application of the various methods must be viewed in the light of the short cuts and elaborate calculating machines now available, since these may lighten the labour for one method more than for another. Attention is called to the fact that the method recently expounded by Awbery is the one given by Cauchy in 1847. AUTHOR.

2378. Pendulum with Oscillating Point of Suspension. P. Hirsch. *Zeits. f. angew. Math. u. Mechanik,* 10. *pp.* 41–52, *Jan.-Feb.,* 1930.

In this mathematical paper the effects of oscillations of a general kind are calculated and the equilibria of such oscillatory pendulums discussed. Part I considers the elliptic oscillation and the physical pendulum, whilst Part II deals with positions of equilibria for linear, circular and elliptical oscillations. H. H. Ho.

2379. Pendulum Observations. E. A. Ansel. *Gerlands Beitr. z. Geophys.* 25. *pp.* 36–52, 1930.

The author deals with the conditions under which the formula mostly employed in the reduction of the time of oscillation for the two-pendulum method fails, and the assumptions made in its use. Formulæ are developed to satisfy the conditions, and the results obtained at a number of German stations from 1911 to 1913 are tabulated and discussed. R. S. R.

2380. Escapement Errors of Pendulum Clocks. E. C. Atkinson. *Phys. Soc., Proc.* 42. *pp.* 58–68; *Disc.,* 68–70, *Feb.* 15, 1930.

Sampson's theory of maintenance is applied to find equations for the errors of rate caused by changes in intensity and limits of the impulse and in friction of moving parts of the impulse mechanism. As an example, the equations are worked out for the Cottingham clock and applied to find best working conditions. Rigidity of the stops limiting the impulse is found to be the most important point in designing this type. The equations are also given for the dead beat escapement, and show that working conditions which are good so far as friction is concerned are bad for barometric changes. The method used for computing "remote" error in these cases must be modified when the inertia of the impulse mechanism is appreciable as in the Shortt clock. The further remote escapement errors due to changes in amplitude introduced by variations of temperature and density of the air are the same as those produced by changes in escapement, but are associated with different direct errors, which are excluded from this paper. AUTHOR.

2381. Twentieth Annual Exhibition of the Physical and Optical Societies. *Journ. Sci. Instruments,* 7. *pp.* 49–54 *and* 74–78, *Feb., and pp.* 81–84, *Mar.,* 1930.

Notes on Exhibits: "Research and Experimental Section," by **E. N. da C. Andrade**; "Meteorological Instruments," by **E. G. Bilham**; "Physiological Apparatus," by **D. T. Harris**; "Educational Apparatus and Experiments," by **C. G. Vernon**; "Historical Exhibits," by **D. Baxandall.**

2382. Motion of Fluids. G. Mazzone-Sangiorgi. *Accad. Lincei, Atti,* 10. *pp.* 633–639, *Dec.* 15, 1929.

Gives practical instances of the motion of water and other liquids [see Abstract 865 (1930)], especially free jets and adhering jets, and shows that they rigidly conform to theory. E. E. F. d'A.

2383. Capillarity. Behaviour of True and Colloidal Solutions during Evaporation in Capillaries. K. Schultze. *Kolloid Zeits.* 50. *pp.* 106–113, *Feb.,* 1930.

Further, not yet completed experiments [see Abstract 1705 (1930)] on the behaviour in capillaries of solutions of methylene blue and night blue, gelatin and agar-agar, as such or mixed with salts, and acid water-glass. The concentration of the dye solutions must be small (0·05 to 0·5 %), not to mask the fine structure of the deposits. H. B.

2384. Measurement of Viscosity of Very Small Quantities of Liquid by Brownian Movement. R. Fürth. *Zeits. f. Physik*, 60. 5–6. *pp.* 313–316, 1930.

A simple method, based on the bilateral average first passage times employed for the measurement of the Brownian movement of separate particles, has now been used for the determination of the viscosity of extremely small quantities of liquid. The theory of the precision of this method is also developed in the paper. H. H. Ho.

2385. Hydromechanics. B. Finzi. *Accad. Lincei, Atti*, 11. *pp.* 59–63, *Jan.* 5, *and pp.* 184–189, *Jan.* 19, 1930.

Mathematical. Finds analytic formulæ for the dynamical actions which a viscous liquid, in plane stationary irrotational motion, exerts upon a line through the effect of viscosity alone. Applies these to finding the dynamical actions exerted upon a rigid closed profile by a regular current, translatory, circulatory, or translate-circulatory. A. D.

2386. Shatter Oscillations, Their Nature and Theory. E. H. Kennard. *Phys. Rev.* 35. *pp.* 428–431, *Feb.* 15, 1930.

Shatter oscillations are an apparently novel type in which the pressure sinks periodically to the minimum value which the liquid can sustain, the liquid mass becoming then porous or " shattered "; they tend to be much slower but more powerful than purely elastic vibrations, and the wave-form is very different, pressure impulses alternating with long intervals of quiet. An experimental case is described and the general theory of such oscillations is developed. Further experiments are needed. AUTHOR.

2387. Generation of Vortices in Relation to Viscosity. S. Sakakibara. *Phys. Math. Soc. Japan, Proc.* 12. *pp.* 38–41, *Feb.*, 1930.

From the general equations of motion in a viscous fluid it is shown that viscosity is fundamental in the growth and decay of already existing vortices, but has no effect on their generation. It appears, in fact, from critical flow velocity experiments that vortices are most easily generated in the perfect fluid. It is concluded that vortices originate where the velocity distribution exhibits singularities, and that viscosity in preventing the formation of singularities acts in effect as an opposing factor in the formation of vortices. W. S. S.

2388. Motion of Vortices with Vertical Axes and of Finite Circular Cross-Section. B. Haurwitz. *Zeits. f. Physik*, 60. 11–12. *pp.* 719–740, 1930.

The work of Helmholtz, Kitao and others on the relative motion of straight vortex filaments is extended to finite vortices of circular cross-section. The velocity within the vortex possesses radial symmetry. Vortices with positive (negative) circulation rotate about one another in a positive (negative) sense. When the horizontal divergence in the vortices is positive or negative respectively, the vortices move farther apart or approach one another. J. S. G. T.

2389. Velocity Distribution in Turbulent Flow. H. Lorenz. *Zeits. f. techn. Physik*, 11. 4. *pp.* 97–102, 1930.

Stream-line flow between plates and in tubes is briefly discussed mathematically, and the limiting case of turbulent flow, the resistance depending upon the square of the velocity, discussed for both plates and tubes. The theory is discussed both for plates at rest and in relative motion. The existence of an annular region surrounding a central core of fluid in which the velocity distribution radially is different is established mathematically and shown to agree with experimental results. J. S. G. T.

2390. Formation of Vortex Motion in the Rear of Immersed Solids. J. Courrègelongue. *Comptes Rendus*, 190. *pp.* 362–365, *Feb.* 10, 1930.

A previous study has been made [see Abstract 1716 (1930)] of the two families of vortices which are formed in the rear of solids immersed in a stream, and this preliminary work is now completed by the description of phenomena which accompany the movement of a solid in an immobile fluid. The results of Prandtl and Tiedjens are incorporated (*Naturwissenschaften*, 13, 1925. p. 1050). The paper is illustrated. H. H. Ho.

2391. Determination of the Diffusion Numbers of Ammonia Towards Air. E. Wintergerst. *Ann. d. Physik*, 4. 3. *pp.* 323–351, *Feb.* 8, 1930.

After a brief survey of the methods for the determination of the diffusion numbers, the possible errors in the Loschmidt method are examined. The greatest error introduced is due to the absorption of ammonia by the walls of the iron tube. Using a seamless steel tube with a very smooth interior, in the Loschmidt method, the diffusion number for the ammonia-air combination is found to be $0\cdot198$ cm.^{2}/sec. at N.T.P. Finally, formulæ for the calculation of diffusion numbers are theoretically developed, and their variations with the mixing proportions, the pressure, and the temperature, are given. Practical examples of the uses of these formulæ are examined. R. C. F.

2392. Absolute Cohesion in Metals. Disruptive Negative Pressures and Critical Disruptive Volumes. R. F. Mehl. *Am. Chem. Soc., J.* 52. *pp.* 534–540, *Feb.*, 1930.

The equation of state for solids, derived by Richards, was used for the calculation of the negative pressures necessary for the disruption of metallic lattices and of the critical volumes at which the disruption should take place. The method yielded a disruptive negative pressure for sodium chloride when the exponents of Born and a suitable transformation are used. The results were in agreement with that which Joffe calculated from Born's potential energy equation. Disruptive negative pressures and critical disruptive volumes were calculated for twelve cubic metals. The constants employed were those given by Richards in his equation of state. The values of the disruptive negative pressures obtained suggest that the tensile strengths of metals and alloys have by no means reached the maximum possible values. F. J. B.

2393. Elastic Properties of Wool in Organic Liquids. J. B. Speakman. *Faraday Soc., Trans.* 26. *pp.* 61–69, *Feb.*, 1930.

Five-cm. lengths of English Cotswold wool were suspended between glass hooks, carefully dried and suspended in the balance arm apparatus previously described [see Abstract 2061 (1929)]. The cross-section of the fibres was measured at 65 % relative humidity by means of a microscope and the extension by a travelling microscope. Five fibres were examined for each reagent, and the energy necessary to extend the fibres by 30 % of their length when in any liquid was determined for alcohols, and graphed against molecular weight. *n*-propyl alcohol appears to be the limiting size to penetrate the fibre pores. Absorption of reagent by wool was determined for these alcohols to test this point by suspending 15 mg. of wool from a quartz spiral balance over P_2O_5, afterwards replacing this by the alcohol and CaO (at 22·2° C.). Results were as follows in percentages absorbed: water, 34 %; methyl alcohol, 28·7 %; ethyl alcohol, 24·4 %; *n*-propyl alcohol, 3·3 %; *n*-amyl alcohol, 0·3 %. Glycol, glycerol and other liquids were also tried. According to the potential energy necessary to extend the fibre 30 % of its original length, glycerol has no effect, but ethylene glycol shows a marked solvation effect, *i.e.*, a lower P.E. is required. Pyridine is almost inert, but mixtures with water lower the potential energy required considerably. Wool either takes up much more than 16 % of water from such a mixture or else takes up pyridine and water together, possibly as hydrate. It is suggested that the protein molecules in a wool fibre are arranged in chains, the lateral attraction being mutually between polypeptide linkages. Any substance combining with this linkage will diminish the attraction and, therefore, the potential energy necessary for 30 % extension. Plasticity is developed by fibres in ethylene glycol. The fact that alcohol is taken up by wool and held against a vacuum (or repeated changes of dry air) being displaced only by water (liquid or over 90 % relative humidity) lends support to the idea of ester formation.

S. G. B.

2394. Propagation of Waves upon Elastic Surfaces having Six Parameters. L. Roy. *Comptes Rendus*, 190. *pp.* 341–344, *Feb.* 10, 1930.

Use is now made of the fundamental equation previously derived [see Abstract 2069 (1930)] for impact waves upon elastic surfaces. The first conclusion is that an elastic surface of six parameters may not be the seat of any impact wave which is propagated. Two cases are discussed, *viz.*, when the surface is a good conductor of heat and when a poor conductor. All the results are analogous to those obtained previously for the elastic line.

H. H. Ho.

2395. Dynamics of Strings and Ropes. Parts I, II and III. Sudden Alterations of Load. H. Schmidt. *Zeits. f. Physik*, 59. 1–2. *pp.* 117–131, 1929; 60. 3–4. *pp.* 269–283, *and* 60. 9–10. *pp.* 702–711, 1930.

In order to explain the method of integration employed in the whole investigation the case of a purely static distribution of constant load is dealt with. The solution for the case of a sudden alteration of the load is then given. It is shown that when a load is suddenly applied the cord vibrates about the position of statical equilibrium, the maximum distances of points on the cord from their original positions of rest being twice the statical deflection. The maximum dynamical stress in the cord is in this case four times the purely statical stress, which corresponds to the upper limit found for elastic systems by Levi-Civita. When the load is suddenly removed the resulting vibrations do not increase the stress in the system above that in the previously existing statical state. Part II deals with the motion of a load with uniform velocity along the rope, and Part III with the effect of braking the motion of the load.

H. N. A.

2396. Brachistochronic Motion of a Dynamical System. A. J. McConnell. *Roy. Irish Acad., Proc.* 39. *A.* 4. *pp.* 31–48, *Jan.*, 1930.

The brachistochronic motion of a holonomic dynamical system with

N degrees of freedom and acted on by a conservative force system, is considered. By this is meant a motion such that the time of passage from one configuration to the next is a minimum. The curves corresponding to this type of motion in the manifolds of configurations and of configurations and time, are worked out in detail, examples for various force systems being given. In the case of the manifold of configurations and time the curves of brachistochronic motion are the null-geodesics of the manifold. The paper is mathematical throughout. G. C. McV.

2397. Iso-Energetic Movements. R. L. Gomes. *Accad. Lincei, Atti*, 11. *pp.* 180–184, *Jan.* 19, 1930.

Mathematical. In a holonomous and conservative system finds a "coefficient of dilatation in time" γ, a "coefficient of dilatation in a space E," λ, and a "coefficient of dilatation in a space 8_1," λ_1. Then shows that $\lambda = \frac{1}{2}(\lambda_1 + \gamma)$, which is useful in problems of stability of iso-energetic movements. A. D.

2398. Incipient Motion in a System with Reversible Bonds. E. Gugino. *Accad. Lincei, Atti*, 11. *pp.* 284–288, *Feb.* 2, 1930.

For every material system with bonds, bilateral, frictionless, reversible and mutually drawn together, starting from a generic configuration C at the time t, the bonds and the mutual attractions remaining unchanged, the energy of acceleration of the system Q^*, under the effect of any motion M^* realised with a velocity v_1^* applied in common being compatible with the bonds, is never less than the analogous energy of acceleration Q° relative to the motion M° starting from rest. A. D.

2399. Critical Investigation of Literature Formulae for Disturbance of Projectile Motion in Vacuum by the Earth's Rotation. O. v. Eberhard. *Zeits. f. Physik*, 60. 7–8. *pp.* 528–557, 1930.

This mathematical paper commences with an analysis of the assumptions made by various authors in their studies of projectile motion, as a basis for the subsequent criticism of their formulæ. The inner connection is then sought between the separate solution systems. A chapter is finally devoted to the kinematics of relative motion. H. H. Ho.

2400. Resistance of Impact on Water Surface. Part I. Cone. S. Watanabe. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 226. *pp.* 251–267, *Feb.* 20, 1930. *In English.*

Continuous resistance-time and depth-resistance curves giving the resistance experienced by a cone of angle 160° due to impact on a water surface are derived by the piezoelectric and kathode-ray oscillograph method previously described. The respective resistances attain maximum values and then decrease suddenly. The maximum values are given by the equations $R_m = 50\mathrm{HM}/(\mathrm{M} + 0\cdot225) = 25\frac{\mathrm{V}^2}{g}\mathrm{M}/(\mathrm{M} + 0\cdot225)$, in which H is the height fallen by the body of total weight M, and V is its velocity of fall. When the height of the cone exceeded a definite value, the depth at which the maximum resistance occurred was independent of the height of the cone. J. S. G. T.

2401. Crystalline Structure of the Neutral Carbonates of Cobalt and Nickel. A. Ferrari and C. Colla. *Accad. Lincei, Atti*, 10. *pp.* 594–598, *Dec.* 1, 1929.

Crystals of normal cobalt carbonate possess a rhombohedric structure of the calcite type, the dimensions of the unit cell, which contains four molecules, being $a = 5\cdot91 \pm 0\cdot005$ Å., $\alpha = 103° 22'$; the density is 4·24. Although nickel compounds are more widespread in nature than those of cobalt, normal nickel carbonate has never been found occurring naturally, and attempts to prepare it synthetically have proved unsuccessful.

T. H. P.

2402. Crystal Structure of Neon. J. de Smedt, W. H. Keesom and H. H. Mooy. *K. Akad. Amsterdam, Proc.* 33. 3. *pp.* 255–257, 1930. *Comm. No.* 203*e from the Phys. Lab., Leiden.*

Only four sharp and intense lines are obtained in the Debye-Scherrer diagram of solid neon. These correspond to a face-centred cubic lattice with lattice constant 4·52 Å. The density at a temperature slightly higher than the boiling point of helium is calculated to be 1·443. The distance between the centres of the nearest neighbouring atoms (from the crystal structure) is 3·20 Å., the diameter of the neon atom (from viscosity data) is 2·36 Å., giving a ratio of 1·35. The analogous ratio for argon is $3\cdot84/2\cdot97 = 1\cdot29$. A. J. M.

2403. Difference Between Natural and Artificial Pearls in Ultra-Violet Light. J. A. A. Leroux, E. Raub and K. W. Fröhlich. *Zeits. f. Physik,* 60. 5–6. *pp.* 307–312, 1930.

An earlier paper by the same authors [see Abstract 2072 (1928)] describes the method of utilisation of short wave-length light for the detection of artificial or synthetic pearls as compared with real ones. A note of warning is now issued since by transmitted light it is possible to get great similarity in effect if the synthetic variety is held in a certain direction relative to the incident light. It is shown, however, that this can be avoided, and the correct technique is outlined. The pictures resulting from transmission of the pearls by ultra-violet light in different directions are given and fully explained so that the various types may easily be detected by comparison and observation of the facts demonstrated pictorially. S. G. B.

2404. Crystal Structure and Shock Sensitiveness of Rubidium and Barium Azides. P. Günther, J. Porger and P. Rosbaud. *Zeits. f. phys. Chem.* 6. *Abt. B.* 6. *pp.* 459–480, *Feb.*, 1930.

Rubidium azide ($d = 2\cdot7876 \pm 0\cdot0006$) is holohedral-tetragonal, space-group D_{4h}^1, the unit cell contains 1 mol., and has $a = 4\cdot497$, $c = 3\cdot707$ Å. The rubidium atoms are at $\frac{1}{2}\frac{1}{2}\frac{1}{2}$; the nitrogen atoms in a line at 000, $00u$ and $00\bar{u}$, ($u = 0\cdot30_4$). Barium azide ($d = 2\cdot9365 \pm 0\cdot0025$) is, contrary to previous statements, holohedral monoclinic, space-group C_{2h}^1 or C_{2h}^2 (rotation diagrams were only obtainable in the directions of the axes, and, though the salt could be powdered in an agate—not a porcelain—mortar without deflagration, the powder method gave no satisfactory result); the unit cell contains 10 mols., and has $a = 6\cdot22$, $b = 29\cdot29$, $c = 7\cdot02$ Å. Shock sensitiveness was determined by Kast's drop-hammer method. In this respect barium azide is very similar to pentanitroerythritol. The sensitiveness of rubidium azide is substantially less, but is greater than that of cast TNT. According to Goldschmidt the normal radius of the nitrogen atom is 0·71 Å., the above structure allows only 1·17 Å. as the distance between the nitrogen atoms in sodium azide and 1·13 Å. in rubidium azide. The compression in the latter is thus some 20 % more than in the sodium salt, and to this is attributed its shock sensitiveness. C. A. S.

2405. Crystal Structure of Sodium Perchlorate. W. H. Zachariasen. *Zeits. f. Krist.* 73. *pp.* 141–146, *Feb.*, 1930. *In English.*

The oscillation method was used. The symmetry is holohedral rhombic, the unit cell ($a = 6\cdot48$, $b = 7\cdot06$, $c = 7\cdot08$ Å.; corresponding to $a : b : c = 0\cdot918 : 1 : 1\cdot003$) contains 4 mols.; space-group V_h^{17}. 4N*a* are at ($u_1\frac{1}{4}0$), 4Cl at ($v_1\frac{1}{4}0$), 8O at (u_2v_20), and 8O at ($u_3\frac{1}{4}v_3$), where $u_1 = 0\cdot65$; $v_1 = 0\cdot15$; $u_2 = 0\cdot31$; $v_2 = 0\cdot08$; $u_3 = 0$, and $v_3 = 0\cdot17$. The 4O in the ClO_4 form a tetrahedron, Cl–O = 1·56 Å., O–O = 2·51 Å. Each Na atom is surrounded by 8O, Na–O = 2·50 Å. Sodium perchlorate is isomorphous with anhydrite. C. A. S.

2406. Structure of Micas and Related Minerals. L. Pauling. *Nat. Acad. Sci., Proc.* 16. *pp.* 123–129, *Feb.*, 1930.

Mauguin's structure for muscovite [see Abstract 2821 (1927)] is confirmed by means of oscillation and Laue photographs of fuchsite, and that of hydrargillite [$Al(OH)_3$] determined ($a = 8\cdot70$, $b = 5\cdot09$, $c = 9\cdot76$ Å.; $\beta = 85° 29'$; 8 mols. in unit cell). The structures of these and of β-tridymite, β-cristobalite and brucite and their relations to pyrophillite, talc and biotite are discussed and figured. The following sequences of atom-planes along the pseudo-hexagonal axes are deduced: pyrophillite (1) 6O, (2) 4Si, (3) [4O + 2(OH)], (4) 4Al, (5) [4O + 2(OH)], (6) 4Si, (7) 6O; and muscovite (1) 6O, (2) (3Si + Al), (3) [4O + 2(OH, F)], (4) 4Al, (5) [4O + 2(OH,F)], (6) (3Si + Al), (7) 6O, (8) 2K. By replacing 4Al in (4) by 6Mg pyrophillite becomes talc, and muscovite, biotite. The physical properties, and (so far as yet measured) the intensities of reflection of X-rays, agree with these structures, which hold also for the clintonites or brittle micas. The generalised formula for the micas is $KX_nY_4O_{10}(OH,F)_2$, where n is not less than 2 or greater than 3, X is a kation of coordination number, 6 (Al, Mg, Fe″, Fe‴, Mn″, Ti, Li, etc.), and Y one of coordination number, 4 (Si, Al); potassium may be replaced by sodium or partially by calcium. [See also Abstract 2672 (1929).] C. A. S.

2407. Possible Influence of the Surrounding Medium on the Symmetry of Certain Minerals. L. Royer. *Comptes Rendus*, 190. *pp.* 503–504, *Feb.* 24, 1930.

The (111) face of a crystal of sulphur, etched by crude petroleum (from Gabian, Hérault), shows rhombic bisphenoidal (V) symmetry in accordance with the usual classification of sulphur; another portion of the same face etched with carbon disulphide indicates holohedral (V_h) symmetry. The same petroleum etches calcite in the same way as an active acid [see Abstract 2358 (1929)]. It is concluded that sulphur is really rhombic holohedral, and that its hemihedrism is solely due to activity of the medium in which the crystals were formed. Brown peat water is also an active material. [See also Abstract 1315 (1930).] C. A. S.

2408. Amplitude of Vibration of Ions in Crystals of NaCl, NaF, LiF and KCl. G. W. Brindley. *Phil. Mag.* 9. *pp.* 193–203, *Feb.*, 1930.

Gives a brief account of the dependence of intensity of X-ray reflection on thermal vibration and charge distribution of the scattering centres in a crystal. The charge distribution in an ion at rest in a crystal is assumed, on the experimental evidence of James and others, to be given approximately by Hartree's method for the charge distribution in a free ion. By comparing X-ray scattering curves (F curves) obtained experimentally for a number of ions at room-temperature with the corresponding theoretical curves for the ions at rest an estimate, shown graphically, has been made of the amplitude of vibration of the ions at room-temperature. W. H. Ge.

2409. Plastic Deformation. N. Dawidenkow. *Zeits. f. Physik,* 61. 1–2. *pp.* 46–53, 1930.

Attempts to explain the phenomena observed by Classen–Nekludowa with reference to plastic deformations [see Abstract 3239 (1929)]. The deformation is conceived to be due to two things: a sudden decrease in the resistance of forming after the commencement of flow, and its re-establishment due to recrystallisation. R. C. F.

2410. Parachor of Chlorine Dioxide. G. H. Cheesman. *Chem. Soc., J. pp.* 35–37, *Jan.*, 1930.

The parachor of chlorine dioxide is found to be 98·7, and as the sum of the atomic parachors of the constituent elements is 94·3, a structural parachor of + 4·4 units remains. Of the eleven electron distributions possible on the assumption that all octets are completed, two are chosen as giving the closest agreement with the observed value of the parachor, but further work is necessary in order to settle the structure. T. H. P.

2411. Parachor and Chemical Constitution. Part XIV. Tellurium Compounds. F. H. Burstall and S. Sugden. *Chem. Soc., J. pp.* 229–234, *Feb.*, 1930.

In earlier papers of this series [see Abstract 3475 (1929)] a number of compounds of sulphur and selenium have been examined in which these elements exert a valency which is greater than the normal, *viz.*, 2. In every case the shell of eight electrons around the sulphur or selenium atom is not exceeded, and the parachors show the presence of the correct number of semipolar double bonds or singlet linkages which are necessary to maintain the octet. This conclusion is extended to tellurium compounds in the present paper, the dialkyl- and diaryl-tellurium dihalides being remarkably stable substances suitable for measurements at a considerable temperature interval above their melting points. H. H. Ho.

2412. Polarities and Orienting Influence of Substitutes in the Benzene Ring. W. M. Latimer and C. W. Porter. *Am. Chem. Soc., J.* 52. *pp.* 206–211, *Jan.*, 1930.

A general theoretical paper in which a system is proposed to serve as a means of classifying groups exerting different orienting influences in the benzene ring. The plan applied is to estimate from considerations of electronic configurations the residual charge on the atom attached to the ring. J. K.

2413. Revision of Classical Theory of Collision in a Gas. J. Frenkel. *Zeits. f. Physik,* 59. 9–10. *pp.* 640–648, 1930.

It is suggested that a more satisfactory account of collision processes in gases is to be obtained if coefficient of viscosity is made the fundamental concept rather than mean free path. The term coefficient of viscosity is defined and a method developed for calculating it. This calculation is further carried out on the basis of the wave-mechanics collision theory for the special case of repulsive forces. Attractive forces are discussed briefly. F. J. W.

2414. Collision between Two Electrons. N. F. Mott. *Roy. Soc., Proc.* 126. *pp.* 259–267, *Jan.* 1, 1930.

Discusses collision between two identical particles with spin (electrons) and between two without spin (α-particles), assuming an inverse square law of force between the particles; and, neglecting the actual spin forces, deduces from the symmetry properties of the wave-functions a scattering law differing considerably from the classical; the exclusion principle discussed in a previous paper is made use of [see Abstract **506** (1930)]. A graph shows the ratio of quantum-theory to classical-theory scattering for electrons for different angles and different velocities. The curves are fairly complicated, and the ratio may range from about 0·5 to about 1·3 in different cases. E. J. Williams has examined the forked tracks produced in a Wilson chamber by photoelectrons in air; the number scattered between 23° and 30° is 0·9 of the number expected on the classical theory and between 30° and 45° is 0·6 of the classical number. The accuracy was not more than 10 %. The author's theory gives 0·8 and 0·6 for the above angles, so that the agreement with experiment is satisfactory. When α-particles are fired into helium a different law of scattering is obtained; the graph of the ratio of quantum-theory to classical-theory scattering has a maximum at 45°; the maximum value of the ratio is 2. To show the effect the α-particles would have to be so slow that the structure effect, which tends to mask it, would have to be negligible. H. N. A.

2415. Possible Wave-Like Structure of an Electron. U. Kakinuma. *Phys. Math. Soc., Japan, Proc.* **12.** *pp.* 25–31, *Feb.*, 1930.

Modifies and extends previous work [see Abstract **2543** (1929)]. An expression for the line element inside the electron is obtained which corresponds to that of Einstein's cylindrical world multiplied throughout by the factor $B \cos^2\omega t$, where B and ω are constants. W. S. S.

2416. Electrons and Protons. P. A. M. Dirac. *Roy. Soc., Proc.* **126.** *pp.* 360–365, *Jan.* 1, 1930.

The difficulty of the negative energy electron is discussed and a solution is proposed. Such electrons move in an external field as though carrying a positive charge. The most stable states for an electron—the states of lowest energy—are those with negative energy and very high velocity. All the electrons in the world will tend to fall into these states with emission of radiation. Assume there are so many electrons in the world that all the states of negative energy are occupied except perhaps a few of small velocity. Any electrons with positive energy will now have very little chance of jumping into negative-energy states and their behaviour will be as usually observed. There will be an infinite number of electrons in negative-energy states, but if their distribution is exactly uniform they will be completely unobservable. Only the small departures from exact uniformity, brought about by some of the negative-energy states being unoccupied, can be observed. The properties of the vacant states or "holes" are discussed. These holes will be things of positive energy and in this respect like ordinary particles. The motion of one of these holes in an external electromagnetic field will be the same as that of the negative-energy electron that would fill it, and will thus correspond to its possessing a charge $+ e$. This leads to the assumption that the holes in the distribution of negative-energy electrons are the protons. When an electron of positive energy drops into a hole and fills it up an electron and proton disappear together with emission of radiation. This theory is applied to the problem of the scattering of radiation by an electron, free or bound. J. J. S.

2417. Ratio of Masses of Proton and Electron. H. Greinacher. *Zeits. f. Physik*, 60. 5–6. *pp.* 285–291, 1930.

Fürth's recent deduction of this ratio depended on assuming the electron to fill all space, its density falling off exponentially from the centre, its radius being defined as equal to that of a surface electron of the same charge moment [see Abstract 912 (1930)]. The present paper works out the consequences of assuming a charge distribution which falls off as some power *n* of the distance from the centre. In general, a value for the ratio of the masses smaller than Fürth's and the experimental value is obtained, but as *n* tends to infinity the latter results are approached. The present calculation also indicates that as *n* tends to infinity the effective radius steadily diminishes, implying a connection between the point electron and the space-filling electron. W. S. S.

2418. Atomic Form Factor Estimation with Electrons. H. Mark and R. Wierl. *Zeits. f. Physik*, 60. 11–12. *pp.* 741–753, 1930.

Photographically measures the relative values of the electron intensities after reflection from the single crystal surfaces of fine crystalline metal foils. Electrometric measurements of the electron quantity falling on the plate are taken at the same time as the exposure, and these measurements are used to change the blackening values into intensities, the atomic form factors being obtained therefrom. Satisfactory agreement is reached between the values thus obtained and those given by the Bethe theory, showing that with electrons possessing velocities between 30 and 50 kV the influence of the electron shell on the scattering intensity is only apparent at small angles. The deviation of the Rutherford distribution is also found to increase with the atomic numbers of the elements producing scattering. R. C. F.

2419. Law of Resistance to Motion of Metallic Particles of High Density in Gases. F. Ehrenhaft and E. Wasser. *Zeits. f. Physik*, 59. 11–12. *pp.* 727–730, 1930.

A review of the present position of this research discloses the necessity to prove the law of resistance without making use of a certain extrapolation. [See also Abstract 531 (1927).] G. E. A.

2420. Resistance to Motion of Oil Particles of Radius $3\cdot4 \times 10^{-5}$ to $11\cdot4 \times 10^{-5}$ cm. by the Ehrenhaft Method. H. Feiner. *Zeits. f. Physik*, 59. 11–12. *pp.* 731–753, 1930.

Mattauch's results for oil particles are tested by means of the Stokes-Cunningham linear law of fall, and also by the Knudsen-Weber exponential law, assuming spherical shape and normal density for the particles. The errors of the two methods are also determined, and a comparison is instituted with those found by Wasser for selenium particles. G. E. A.

2421. Law of Resistance for Gold Particles of Size 1 to 2×10^{-5} cm. in Gases. M. Slopkovitzer. *Zeits. f. Physik*, 59. 11–12. *pp.* 754–770, 1930.

Gold particles were investigated by the Ehrenhaft method. Their charges are found to vary between $3\cdot96 \times 10^{-10}$ and $1\cdot04 \times 10^{-10}$ e.s.u. G. E. A.

2422. Law of Resistance for Particles of Platinum of Size 10^{-5} cm. S. Virtel. *Zeits. f. Physik*, 59. 11–12. *pp.* 771–806, 1930.

By means of an electric arc, platinum particles were produced which were regular in shape, and of radius 1×10^{-5} to 3×10^{-5} cm. These particles conform to the linear and exponential laws of motion in a resisting medium, and the value found for the constant of the law of resistance indicates that the particles have normal density and spherical shape. The calculated electric charges of the particles have a minimum of 2×10^{-10} e.s.u. by the linear law, and 3×10^{-10} by the exponential law. The difference cannot be attributed to inexact measurement or irregularity in the test material. G. E. A.

2423. Limits of Applicability of the Cosine Law for Molecular Rays. F. Knauer and O. Stern. *Zeits. f. Physik,* 60. 5–6. *pp.* 414–416, 1930.

The authors reply to adverse criticism of their results relating to molecular rays by Mayer. [See Abstracts 559 (1927) and 908 (1930).] J. S. G. T.

2424. Diffraction of Molecular Rays. I. Estermann and O. Stern. *Zeits. f. Physik,* 61. 1–2. *pp.* 95–125, 1930.

Molecular rays of hydrogen and helium, scattered by a crystal of lithium fluoride are found to be characterised by an intensity distribution corresponding with that derived from scattering by a cross lattice. The value of λ calculated from the crystal lattice constant agrees with the de Broglie value h/mv, where the symbols have their customary significance. J. S. G. T.

2425. Reflection of Beams of Alkali Metals from Crystals. J. B. Taylor. *Phys. Rev.* 35. *pp.* 375–380, *Feb.* 15, 1930.

Beams of lithium, potassium and cæsium were reflected from crystals of sodium chloride and lithium fluoride, as a means of studying the wave nature of these atoms. Incident angles from 2° to 60° were investigated. Although 0·01 % of specular reflection could have been detected, no trace of such a reflection or of diffraction was found. The measured angular distribution of reflected atoms followed closely the cosine law. Apparatus, and the detecting device depending on positive ion emission by which this sensitivity of measurement was obtained, are described. [See also Abstract 497 (1930).] AUTHOR.

2426. Structure of Molecular from Given Atomic States. W. Weizel. *Zeits. f. Physik,* 59. 5–6. *pp.* 320–332, 1930.

The problem considered is that of deducing the exact atomic state (in terms of its three quantum numbers) resulting when a molecule in a known state dissociates. From consideration of limiting cases, a number of empirical rules are suggested, which are in partial agreement with those suggested by Hund and Herzberg. J. H. A.

2427. Photometry of Mass Spectra and Atomic Weights of Krypton, Xenon and Mercury. F. W. Aston. *Roy. Soc., Proc.* 126. *pp.* 511–525, *Feb.* 3, 1930.

The relative abundance of the various isotopes of krypton, xenon and mercury has been determined by the photometry of their lines in mass spectra by a method described in detail. The percentage amounts of the isotopes are: krypton 78, 0·42; 80, 2·45; 82, 11·79; 83, 11·79; 84, 56·85; 86, 16·70. xenon 124, 0·08; 126, 0·08; 128, 2·30; 129, 27·13; 130, 4·18; 131, 20·67; 132, 26·45; 134, 10·31; 136, 8·79. mercury 196, 0·10; 198, 9·89; 199, 16·45; 200, 23·77; 201, 13·67; 202, 29·27; 204, 6·85. Defining "isotopic moment" as the sum for all isotopes of the products (abundance of isotope) × (distance from mean mass number on mass scale) the isotopic moments are respectively 0·87, 1·71 and 1·40. The figure for mercury (1·40) agrees exactly with that deduced by an entirely different method by Brönsted and Hevesy [see Abstract 1735 (1922)]. From these results the atomic weights deduced are 83·77 ± 0·02, 131·27 ± 0·04 and 200·62 ± 0·05, as compared with the most recent analytical figures of 82·9, 130·2 and 200·6. It is thought that these latter figures are in error for krypton and xenon. C. A. S.

2428. New Regularity in the List of Existing Nuclei. H. A. Barton. *Phys. Rev.* 35. *pp.* 408–414, *Feb.* 15, 1930.

Aston's data form a fairly complete list up to atomic number 81, but in absence of a theory of nuclear constitution, a search for regularities in the list of existing nuclear types may be made. A new type is described in which most of the known nuclei in the range studied fall into three clusters, each characterised by a two-dimensional symmetry. When the nuclei are plotted as points whose ordinates and abscissæ represent the number of protons and electrons respectively in their constitution, for each cluster there exists a centre (P E) such that if there is a nuclear type (P – X, E – Y) there is, in general, also a symmetrical type (P X, E Y). A list of predicted isotopes as yet undiscovered follows as a deduction from a consideration of the relatively few departures from this rule within the clusters. A possible physical explanation is put forward with all reserve. S. G. B.

2429. Experimental Test of Schrödinger's Theory. E. Gaviola. *Univ. Nac. La Plata, Estudio Ciencias, No.* 89. *pp.* 59–64, *Dec.*, 1929.

According to Schrödinger's theory, if two lines are emitted by the same higher level, the relative intensity ought to change if we change the relative population of the lower levels. This conclusion is tested by means of mercury vapour emitting the lines 4358 and 4046 Å., emitted by the same higher level 2^3S_1. The relative population of the two lower levels can be changed several hundred times by introducing a few mm. of nitrogen or water vapour into the mercury vapour. The measurements show conclusively that the ratio is unaffected by the admixture. The author suggests that it may be necessary to modify the relation between the electric charge and the quantity ψ. E. E. F. d'A.

2430. Quantised Rotation of the Potassium Atom. R. G. Loyarte and R. Grinfeld. *Univ. Nac. La Plata, Estudio Ciencias, No.* 89. *pp.* 103–108, *Dec.*, 1929.

Williamson has published curves which show the stimulation of potassium atoms by electron shocks. These curves show it to be probable that there is a quantised rotation of these atoms. The critical potential, which corresponds to the leap from level $n = 0$ to level $n = 1$, must be 3·39 volts, which corresponds to a $\Delta\nu = 27{,}441$ cm.$^{-1}$. On spectroscopic testing, 23 lines of the arc and spark spectra of potassium are found, obtainable by combination of a rotation-quantum leap with the electron leaps. Since the value $\Delta\nu = 27{,}441$ is very large, it is not possible to find lines for which to subtract the rotation-quantum leaps from those of the electrons, for such lines would be in the deep infra-red, where measurements have not been made. The number of combination lines within the observed region is, therefore, small. A. D.

2431. Quantised Rotation of the Atom of Ionised Mercury. R. G. Loyarte. *Univ. Nac. La Plata, Estudio Ciencias, No.* 89. *pp.* 123–133, *Dec.*, 1929.

New lines, which depend upon rotation; partly classified, partly not classified. These confirm the previous finding, that the mercury atom is capable of a quantised rotation. [See also Abstract 1327 (1930).] A. D.

2432. Quantisation of the Asymmetric Top. O. Klein. *Zeits. f. Physik*, 58. 11–12. *pp.* 730–734, 1929.

The present treatment differs from that of Kramers and Ittmann [see Abstracts 2108 (1929) and 1335 (1930)] in that instead of developing the wave equation, Dirac's original methods of non-commutative algebra are employed. Exchange (Vertauschungs) relations are laid down for the components of the moment of momentum, taken with respect to the principal axes of the inertia ellipsoid. These differ only in sign from those applicable to the moment of momentum components referred to axes fixed in space. The exchange (Vertauschungs) relations, together with the classical energy expression in terms of the moment of momentum components, yield the desired quantisation, and lead in a simple way to the eigen energies. W. S. S.

2433. Quantisation of the Asymmetric Top. H. B. G. Casimir. *Zeits. f. Physik*, 59. 9–10. *pp.* 623–634, 1930.

The method used by Klein [see preceding Abstract] to obtain the eigen values of the asymmetric top, is extended to give the intensities. The method represents a direct quantum mechanics translation of the classical mechanics of the rigid body. As a further example of this method, a brief discussion is given of the problem of a top incorporating a flywheel, although there is no direct physical application of this problem. W. S. S.

2434. Quantisation of the Asymmetric Top. H. A. Kramers and G. P. Ittmann. *Zeits. f. Physik*, 60. 9–10. *pp.* 663–681, 1930.

The authors continue previous work [see Abstracts 2108 (1929) and 1335 (1930)] on the eigen values of the asymmetric top. The problem of the order of the eigen values is solved by an algebraic method. Selection rules and intensities for the rotation spectrum are derived. W. S. S.

2435. Quantum Dynamics of Wave Fields. Part II. W. Heisenberg and W. Pauli. *Zeits. f. Physik*, 59. 3–4. *pp.* 168–190, 1930.

The quantum theory of wave fields, as treated relativistically in Part I [see Abstract 3262 (1929)], is still subject to serious objections. In particular the mutual actions between the electrons appear for the present to render the application of the theory impossible in many cases. The final formulation of the theory seems still to be in the distance, but in spite of this it appears that the building up of the wave-theory is essential for further progress of the quantum theory. In the mechanics of points as treated by the quantum theory definite progress has been made by investigation of the invariance properties of Hamilton's function; from these properties it is possible to derive the division of the term systems into non-combining term groups; and in the same way the simple integrals of the equations of motion are related to such invariance properties of Hamilton's function. The paper shows that the invariance properties of the *wave equations* can be made use of in a manner which is quite similar; investigates the resolution of the complete term system into non-combining partial systems, and deduces the integrals of the equations of motion. In addition, a satisfactory formulation of electrodynamics is obtained without additional terms. The mathematical connection between the wave theory and the particle theory is discussed. H. N. A.

2436. Causality in Quantum Mechanics. G. W. Kellner. *Zeits. f. Physik*, 59. 11–12. *pp*. 820–835, 1930.

In considering the problem of many electrons it is necessary to remember that all electrons resemble one another so closely that there is no possibility of distinguishing between them as first electron, second electron and third electron, and it is necessary to use Bose or Fermi statistics, which excludes any recognition of an electron once it has been lost sight of. This makes the previous imaginary experiment [see Abstract 2961 (1929)] impossible when there are many electrons, for it would be necessary to bring them all back to their original places, which could not be done if it were impossible continually to identify them. It is, however, possible to follow the position of a definite particle during a time interval, by imagining its Schrödinger function to be caused to " run together " and kept from flowing apart as in Part I. It has been shown in Part I that impulse and position can both be defined, but cannot be measured at the same time, and the author concludes that in the many body problem the same applies to energy and phase. Shows that the same considerations apply with regard to quanta of light; in certain cases a light quantum radiated by an atom can be concentrated to a point by means of a suitably placed concave mirror. In general, however, the term " path " as applied to a photon has no meaning, since its " position " can only be found by concentrating it, so that the position can be measured. Exactly the same is true of the electrons. Deals with the Compton effect on the above basis; and with many other interesting points in the theory. H. N. A.

2437. Quantum Mechanics of Energy Interchanges. H. Kallmann and F. London. *Zeits. f. Physik*, 60. 5–6. *pp*. 417–419, 1930.

The authors reply to criticisms brought against their work [see Abstract 2361 (1929)] on collision problems by J. Frenkel [see Abstract 1752 (1930)] and justify their results. G. C. McV.

2438. Existence of Non-Combining Groups of Wave Functions, and the Uniqueness of the Solutions of Certain Wave Equations. T. E. Stern. *Cambridge Phil. Soc., Proc.* 26. *pp*. 99–100, *Jan*., 1930.

Amends Ursell's proof of the existence of non-combining states [see Abstract 2920 (1928)]. W. S. S.

2439. Kirchhoff's Formula Extended to a Moving Surface. W. R. Morgans. *Phil. Mag*. 9. *pp*. 141–161, *Jan*., 1930.

In a number of physical problems with moving surfaces Kirchhoff's formula for a fixed surface is not applicable, and a solution of the wave equation is now presented in the form of a surface integral extended to the more complex condition. The method followed is that of Kirchhoff, and the final result shows that the Kirchhoff formula is a particular case of the extended formula when the normal velocity of the surface is equated to zero. The paper is entirely mathematical. H. H. Ho.

2440. Affinity of the Hydrogen Atom for Electrons According to Wave Mechanics. E. A. Hylleraas. *Zeits. f. Physik*, 60. 9–10. *pp*. 624–630, 1930.

The author has previously calculated the tensions of ionisation of the atomic configurations He, Li^+, Be^{++}, etc., and he now extrapolates from these results to find the energy of formation of the ion H^{-1}, which like the above ions has two electrons, from H and a free electron. The value arrived at is 0·700 ± 0·015 volt or 16 kcal./mol. in thermal units.

H. N. A.

2441. Quantum Theory of the Electron. H. Mandel. *Zeits. f. Physik*, 60. 11–12. *pp.* 782–784, 1930.

Dirac's spin variable ζ and the so-called cylindrical coordinate x^5 of R_5 are regarded as a canonically conjugate pair of variables. ζ is thus identified with the elementary charge and may be substituted for x^5 in the wave equation of the electron. The treatment is confined to equations of the second order, which involve only two values of ζ, namely $+e$ and $-e$.

E. E. F. d'A.

2442. Principles and Results of Wave Mechanics. H. Hönl and C. Eckart. *Phys. Zeits.* 31. *pp.* 89–119, *Feb.* 1, *and pp.* 145–165, *Feb.* 15, 1930.

The authors give a detailed statement, starting from first principles, of the fundamental ideas (and their mathematical expression) and all the important physical applications of the wave mechanics (not including, however, the Dirac development by which the single wave scalar ψ is replaced by a four-component wave vector). The connection between the original de Broglie wave (periodic process) and the Schrödinger equation, the Schrödinger conception and the statistical conception of the wave scalar, the Heisenberg uncertainty condition, and the relation between the wave and matrix mechanics are among the special points which receive a brief but lucid treatment. The development is throughout mathematical, but with a full explanation of the physical significance underlying the equations; in addition, a number of critical comments are incorporated and outstanding difficulties of the theory are indicated.

W. S. S.

2443. Field Theory of Dirac's Wave Equation. C. Lanczos. *Phys. Zeits.* 31. *pp.* 120–130, *Feb.* 1, 1930.

A short account of Dirac's theory of the electron followed by a sketch of the author's development of the wave equations in tensor form. Eight ψ-functions are used and Dirac's four wave equations are replaced by a scheme of generalised Maxwell's equations. The new theory involves an alteration in the expression for the line-element: instead of the Euclidean form $ds^2 = \sum_{i=1}^{4} dx_i^2$, the form $ds^2 = \sigma \sum_{i=1}^{4} dx_i^2$, where σ is a "gauge factor," is employed and leads to a space which can be conformally represented on a Euclidean space. The solutions of the new wave equations for the case of spherical symmetry are discussed shortly.

G. C. McV.

2444. Generalised Statistical Theory and Dirac's Recent Quantum Mechanics. K. C. Kar and K. K. Mukherjee. *Zeits. f. Physik*, 60. 3–4. *pp.* 243–249, 1930.

In the first part the relation of Kar and Mazumdar's generalised statistical theory [see Abstract 1333 (1930)] to the recent form of Dirac's quantum mechanics is deduced. In the second part the three- and one-dimensional (variable) form of the Keplerian-orbit problem is solved in terms of group-velocity by the method of integration in series, as employed by Sommerfeld. The forms of the solution clarify the authors' notion of the physical significance of the problem. J. S. G. T.

2445. Fundamental Kinetic Equation in Quantum Statistics. S. Kikuchi and L. Nordheim. *Zeits. f. Physik*, 60. 9–10. *pp.* 652–662, 1930.

The authors investigate the effect of an external disturbing field on the distribution of a statistical assembly in the Fermi-Dirac and Bose-Einstein statistics respectively. It is shown that the transition probabilities in this case can be derived as if only an individual system were concerned. The analysis brings out the connection between the statistical distribution function and the wave-function. The form of the transition probabilities when the individual systems are coupled in various ways is also discussed briefly. W. S. S.

2446. Ionisation Formula and the New Statistics. S. Chandrasekhar. *Phil. Mag.* 9. *pp.* 292–299, *Feb.*, 1930.

In this paper the ionisation formula is considered afresh on the Fermi–Dirac statistics. The modified formula where the degeneracy of the electrons is considered gives, under the conditions existing in the interior of a dwarf star, a degree of ionisation = 0 %. This result is discussed with reference to the theory of dwarf stars, where complete ionisation is usually assumed [see also Abstract 1332 (1930)]. AUTHOR.

2447. Statistical Significance of Einstein's Deduction of Planck's Law [of Radiation]. R. C. Majumdar and D. S. Kothari. *Zeits. f. Physik*, 60. 3–4. *pp.* 250–254, 1930.

The arbitrary character of one of the fundamental equations involved in Einstein's deduction of Planck's law of radiation and the difficulty of comprehending Einstein's notion of induced radiation are briefly referred to. Einstein's objections to Bose's deduction of the law are referred to, more especially, the defect of Bose's theory relating to the fact that the emission is taken simply as an_s, a being a constant. A method of deducing the law along lines whereby this difficulty is eliminated is discussed.

J. S. G. T.

2448. Approximate Method of Solution of the Problem of Many Bodies in Quantum Mechanics. V. Fock. *Zeits. f. Physik*, 61. 1–2. *pp.* 126–148, 1930.

It is well known that the variation principle $\int\delta\bar{\psi}(L - E)\psi d\tau = 0$, (L = energy operator) leads to the wave equation in the configuration space. It is now shown that the additional assumption that $\psi = \psi_1(x_1)\psi_2(x_2)\ldots\psi_N(x_N)$, N being the number of electrons, leads to the equations occurring in Hartree's theory of the "self-consistent" field. This equation, however, has not the correct symmetry. In the important special case of complete degeneracy of the term-system, ψ can be approximately represented by the product of two determinants. The resulting equations for $\psi_i(x)$ contain interchangeable members, and can be regarded as Eulerian equations in a three-dimensional variation problem in which the energy occurs as an action integral. The equations are not much more complicated than those given by Hartree, but should yield more accurate results. J. S. G. T.

2449. Michelson Experiment. G. v. Gleich. *Zeits. f. Physik,* 59. 1-2. *pp.* 132–143, 1929.

The correct result of the Michelson experiment is still an open question, though the Lorentz transformation and the whole theory of relativity are based on the supposed negative result, that is to say, no " ether drift " or possibly no ether. If the ether is to be regarded as fixed in space there will be a daily varying ether drift to be considered in the Michelson experiment, a yearly varying drift and a constant drift depending on the motion of the solar system through space; it is only the latter which can have a perecptible effect, as the others are too small. Works out mathematically a corrected form of the Lorentz formula, which shows that the Michelson effect would in any case be very small. Considers the connection between Fresnel's formula for the velocity of light in a moving medium and the Michelson experiment, and Einstein's addition theorem. See also **A. Model,** *ibid.* 61. 3–4. p. 290, 1930. Reply by **G. v. Gleich,** *ibid.* pp. 291–296, 1930. Admits the mistake pointed out by Model, but continues his argument against the theory of relativity. H. N. A.

2450. Relativity and Ether Drift. W. F. G. Swann. *Phys. Rev.* 35. *pp.* 336–346, *Feb.* 15, 1930.

While ether-drift experiments originally suggested the line of thought which led to the formation of the restricted theory of relativity, it would seem that the fundamental significance of that theory does not depend primarily upon these experiments. The most logical origin of the transformation of the restricted theory is to be found as a special case of the general theory, and the purpose of the present paper is to show how, with this in view, the fundamental working content of the restricted theory, the invariance of laws under the Lorentzian transformation, is something which has no fundamental relation to the question of whether the ether-drift experiments do or do not give a positive result.

AUTHOR.

2451. Two Contradictions in Current Physical Theory. F. S. C. Northrop. *Nat. Acad. Sci., Proc.* 16. *pp.* 65–68, *Jan.,* 1930.

The special and general theories of relativity have given rise to two new contradictions in current physical theory, which can be escaped only by an amendment to the traditional atomic theory. The first contradiction is shown by three propositions: (1) Atomicity is an unescapable fact. (2) Atomicity and the motion which it involves necessitate the existence of a referent in addition to the microscopic particles. (3) No such referent exists according to current scientific theory. In considering the nature of the new referent for atomicity and motion which is required the second contradiction appears, which is indicated by three propositions: (*a*) The metrical properties of space are conditioned by the motion and distribution of matter. (*b*) The space of this universe possesses an approximately constant metrical uniformity which extends over macroscopic distances. (*c*) Matter as conceived by current physical theory is incapable of producing this uniformity. Thus, some other basic entity in addition to the microscopic particles must exist in the universe. The author finds this in the existence of a large macroscopic atom, spherical in shape and hollow in its interior except for its inner field, which contains and congests all the microscopic atoms of the traditional atomic theory.

J. J. S.

2452. Invariant Formulation of the Laws of Conservation in General Relativity Theory. C. Lanczos. *Zeits. f. Physik*, 59. 7–8. *pp.* 514–539, 1930.

A new method of obtaining, from the differential form of the law of conservation of impulse and energy, the integral form of the law. The problem is treated as a boundary problem, and the method gives, in a systematic and covariant way, all possible conservation theorems. Starting from the differential form of the conservation law, use is made of the "adjoint differential equation" and the integral form attained. In the case of special relativity the method gives six conservation laws, in addition to the usual law of conservation of impulse and energy. Three of these new laws give the conservation of angular momentum; the other three, the motion along a straight line of the centre of gravity of a moving body. The law of motion is thus arrived at without assuming that the energy tensor has the form $T_{ik} = \mu \dot{x}_i \dot{x}_k$. The method is then extended to general relativity, and it is shown that the law of motion of the centre of gravity of a body can be derived from it, in the case when the field considered is stationary. G. C. McV.

2453. Phase Velocity in Relation to the Kinematics of the Theory of Relativity. L. Strum. *Zeits. f. Physik*, 60. 5–6. *pp.* 405–409, 1930.

In connection with the author's previous discussion of velocities in excess of that of light [see Abstract 61 (1927)], it is shown that the notion of phase velocity can be quite naturally introduced into the kinematics of the theory of relativity. Formulæ, based upon the usual equation for the addition of velocities, enable one to transform the phase velocity of a body relative to a system S into its corresponding phase velocity related to a system S′ in relative motion with regard to S. J. S. G. T.

2454. Motion of Light and Matter in a Gravitational Field. J. Kunz. *Phys. Zeits.* 31. *pp.* 83–87, *Jan.* 15, 1930.

The author shows it is possible to calculate the rotation of the perihelion of Mercury, the deflection of a ray of light by the sun and the displacement of the lines of the sun's spectrum to the red without the use of the non-Euclidean geometry of relativity theory. The method assumes the result of quantum theory that light of frequency ν has mass $m = \frac{h\nu}{c^2}$ and that the potential energy of the gravitational field manifests itself (in the motion of the light ray) as a change of frequency of the ray. The results are derived from the principle of the conservation of energy and the two masses, transversal and longitudinal, of a mass in motion, whether ordinary matter or energy, are employed throughout.
G. C. McV.

2455. Law of Gravitation. F. Girault. *Comptes Rendus*, 190. *pp.* 41–42, *Jan.* 6, 1930.

In a previous paper [see Abstract 1186 (1928)] the author has shown that in the case of a spherical gravitational field there exist a triply infinite number of laws satisfying the principle of relativity. There is a certain element of indeterminateness about such a field in that the Euclidean distance from a point in the field to the centre of the mass in the field is experimentally indeterminable. This difficulty is removed, in the author's theory, when the field of an infinite plane is considered, and the author considers that the properties of such a field confirm the validity of his theoretical results rather than those of Einstein, from which they differ slightly, but with which, to a first approximation, they agree. J. S. G. T.

2456. Utility of the Jaumann Theory of Gravitation. F. Hlučka. *Zeits. f. Physik*, 60. 7–8. *pp*. 558–575, 1930.

Based upon theoretical considerations and empirical data, it is shown that the Jaumann theory of gravitation, with the introduction of a positive gravitational potential and in its extended form, appears suitable for explanation of the anomalies of planetary orbits. This enables the numerical evaluation of some characteristic complex constants of the Jaumann theory. H. H. Ho.

2457. Illuminated Space-Time: Optical Effects of Isotropic Radiation Spread over Elliptic Space. L. Silberstein. *Phil. Mag*. 9. *pp*. 50–57, *Jan*., 1930.

A rigorous solution is given of Einstein's gravitational equations $R_{ik} - \frac{1}{2}(R - 2\lambda)g_{ik} = - kT_{ik}$, corresponding to a universe uniformly filled with isotropic radiation. This universe is analogous to de Sitter's, being spherical and of constant radius. The new radius of the universe, compared to that of de Sitter's, is reduced in the ratio $1 : (1 - 10^{-8})$. G. C. McV.

2458. Region of Convergence of Series [of Spherical Harmonics] Expressing the Potential of External Space. F. Hopfner. *Gerlands Beitr. z. Geophys*. 25. 3–4. *pp*. 336–338, 1930.

It is shown that the spherical harmonic series expressing the potential at a point external to an attracting mass is convergent also with reference to a definite region *within* the attracting mass. J. S. G. T.

2459. Linear Transformations in Hilbert Space. Part III. Operational Methods and Group Theory. M. H. Stone. *Nat. Acad. Sci., Proc*. 16. *pp*. 172–175, *Feb*., 1930.

The present paper continues a previous investigation [see Abstract 2687 (1929)] of the theory of transformations in Hilbert space, and on the basis of results already outlined, the foundations are now laid for an operational calculus. An application is given to a field in which few results have been published hitherto, *viz*., group-theoretic questions of fundamental importance in quantum mechanics; solutions are given of the unitary representations of the group of translations of a straight line into itself; and the Heisenberg permutation relations connecting the self-adjoint transformations P_k, Q_k, $k = 1, \ldots, n$, which in quantum mechanics refer essentially to the coordinates and momenta of a dynamical system of n-degrees of freedom. H. H. Ho.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

2460. Practical Pyranometry. K. N. Wassiliew. *Gerlands Beitr. z. Geophys.* 25. 2. *pp.* 230–234, 1930.

Ångström found strips coated with MgO best for pyranometers. The results obtained for a pyranometer with (1) MgO coated and (2) blank strips are given to test the applicability of the cosine law. The radiation is obtained with a compensation pyranometer using the formula $q = ci^2$. Values of c are found for solar radiation of different wave-lengths, and they are approximately the same for the distribution in the spectrum of the light from the sky, but c may not be the same for diffuse radiation. The table of results shows that the differences are generally within the limits of experimental error. The values for the MgO strips are rather greater than those for the cosine law, probably due to internal reflection in the vessel. This holds also for the plain strips. Consequently the cosine law holds for a pyranometer with MgO strips, as also for the pyrgeometer with blank strips for all wave-lengths, even to the ultra-violet. R. S. R.

2461. Cold and Warm Winters and Summers in Relation to Axial Oscillations of the Earth. R. Spitaler. *Gerlands Beitr. z. Geophys.* 25. 2. *pp.* 211–229, 1930.

The author considers that changes in the axis of the earth give rise to large scale horizontal and vertical air movements and disturb the normal distribution and displacement of the air masses. As a result they exert an influence on the deviation of temperature from the long period seasonal values. The period 1890–1923 was investigated, and observations for Vienna were employed to illustrate these views for cold and warm winters and summers. The probable air movements which produce these changes are explained. Baur's mean figures for middle Europe are used similarly, but the results are partly smoothed out. The effect is shown also in West Greenland, and opposed anomalies are found for the middle of North America and the middle of Asia. [See also following Abstract.] R. S. R.

2462. Terrestrial Axis Variations and Temperature Anomalies. R. Spitaler. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 429–441, 1930.

It is known that the axis of the earth undergoes rotations in which the polar axis executes deviations ranging from 0·056 to 0·234 sec. of arc, and that these variations are repeated in cycles of six years. The data for the successive six-year cycles 1890–95, 1896–1900 and onwards have been previously given by the author [see Abstract 538 (1930)]. These data also show the orientation, in degrees of longitude, of the deflected axis round the mean polar axis at different times. In previous papers [see Abstract 538 (1930) and preceding Abstract] the author, starting with the observed temperature and barometric anomalies, calculated the theoretical polar-axis positions. In the present paper he reverses the order of the enquiry, starting with the observed polar-axis positions. Let L° be the longitude of the locality (*e.g.*, Vienna, L = 16·2° E. of Greenwich); and let λ° be the angular orientation of the deflected polar axis; then when $\lambda = L$, the locality lies under a "positive" meridian. The locality lies under a positive meridian at later dates in the successive years of the six-year cycle. When $\lambda = L \pm 90°$, the locality lies under a " neutral " meridian; and when $\lambda = L \pm 180°$, it lies under a " negative " meridian. The influence of the tilt in producing movement of masses of air is [see Abstract 538 (1930)] proportional, *inter alia*, to cos $(L - \lambda)$; it is, therefore, a maximum when the locality lies under a positive meridian, zero when it lies under a neutral, and again a (smaller) maximum when it lies under a negative meridian. These events happen at later and later dates in the successive six years of the cycle. Comparison of data and dates shows that in Vienna a winter spent under the predominating influence of the positive meridian tends to be warmer; if of the negative, colder. Vienna being at about latitude 45°, the warmer winter is associated with a downfall of air, which tends to prevent a north wind from blowing; in cold winters the opposite is the case. In the summer, in Vienna, if the influence of the positive meridian predominate, the temperature is lower; there is a downfall of air, and a flow towards north and south, which checks the south wind. Vienna ought to have a warmer winter 1929–30 and a cooler summer 1930. A. D.

2463. Effect of Vertical Convection on Lapse Rates. C. G. Rossby. *Washington Acad. Sci., J.* 20. *pp.* 33–35, *Feb.* 4, 1930.

In an investigation of the modification of lapse rates produced by vertical movement the expression is obtained

$$\left(\frac{dT}{dz}\right)_1 = \frac{p_1}{p_0}\left\{\left(\frac{dT}{dz}\right)_0 + \frac{Ag}{c_p}\right\} - \frac{Ag}{c_p},$$

where dT/dz represents the lapse rate for a pressure p, A is the reciprocal of the mechanical equivalent of heat, g is the acceleration due to gravity, and c_p the specific heat at constant pressure. The explanation of inversions, caused by subsidence, follows from the equations obtained. R. S. R.

2464. Shape of the Earth. C. Somigliana. *Accad. Sci. Torino, Atti*, 64. 1*a*. *pp.* 4–10, 1928–1929.

The question of determining the shape of the earth from the value of the gravity constant is discussed. It is concluded that the amount of flattening can be determined, but not the dimensions of the ellipsoid. W. A. R.

2465. Hypotheses on the Development of the Earth. B. Gutenberg. *Washington Acad. Sci., J.* 20. *pp.* 17–25; *Jan.* 19, 1930.

The outer sial layer was removed from the area from which the moon was thrown off, leaving that area covered with the heavier sima, and also deeper, a result accentuated by accumulation of water thereon. The remaining sial-covered area formed the continental block. For long after this event there was much movement, the first quiescent period being the carboniferous, when climatic evidence points to the continents being mainly in the southern hemisphere. Their drift apart is due to hydrostatic forces—the continental matter in regions of less strength flowing and spreading—and to the centrifugal (" polflucht ") forces tending to drive the continents towards, and equally north and south of, the equator, while the actual movements of drift tended to produce high mountains on the borders of the continental block. The effects of shrinkage due to cooling, sedimentation with consequent formation of geosynclines, and of isostasy are discussed, and it is concluded that hereafter there will be no great movements of the continents, but that these will continue to spread and sink. Shrinkage due to cooling and the " polflucht " forces will cause a new orogenic period near the equator. Changes in climate, such as caused the glacial periods, are due to astronomical causes. C. A. S.

2466. Geodesy and Precession. R. Wavre. *Arch. des Sciences,* 11. *pp.* 295–311, *Nov.–Dec.,* 1929, *and* 12. *pp.* 11–30, *Jan.–Feb.,* 1930.

Shows that if whole numbers only are considered the depression 1/294 is, in all cases, comparable with the fundamental measurements. The numbers 293 and 295 can also be admitted as correct, but all others are definitely excluded. The agreement between the theory of the precession and geodesy is obtained in the second approximation, whilst the disagreement emphasised by Poincaré can be explained by the influence of the term containing the fourth power of the angular velocity. The divergence in question can be explained without renouncing the hypothesis of the fluidity of the globe and without recourse to Einstein's theory. This number 294 appears to answer Allembert's problem regarding the agreement between geodetic and precessional measurements. The paper is entirely mathematical. R. C. F.

2467. Oceans and Continents. W. Bowie. *Gerlands Beitr. z. Geophys.* 25. 2. *pp.* 137–144, 1930. *In English.*

It is difficult to see how continents and ocean basins could have been formed by processes operating within the earth itself. Tidal forces acting in the early stages of planetary history must be appealed to, and naturally the question becomes connected with the formation of the moon. If the moon were formed by tidal forces disrupting the crust, consideration shows that there must have been much fissuring in the crustal material prior to disruption. The crust would thus be divided into blocks, which formed, later, the continental masses. W. A. R.

2468. Distribution of Mass at the Earth's Surface. L. Kober. *Gerlands Beitr. z. Geophys.* 25. 2. *pp.* 163–174, 1930.

The author considers that the distribution of mass over the earth depends upon a tendency for land and water masses to balance, upon the amount and density of each, the inner structure of the earth and its rotation, and on the mobility of the interior land masses. He considers that a regional compensation between land and water exists. He obtains an inverse relation between the quantity and density of land and water masses, and considers this relation is exemplified in the existing distribution of land and sea. The bearings of these views on the sial-sima theory for the earth's structure and on geological and geophysical phenomena are discussed. R. S. R.

2469. Ranges and Phase Displacements of Earth and Ocean Tides. New Investigation Based on Experiment by A. A. Michelson and H. G. Gale. J. C. Dobbie. *Roy. Astron. Soc., M.N., Geophys. Supplement.* 2. *pp.* 233–259, *Feb.,* 1930.

Michelson and Gale, by observations of the movements of water in two horizontal pipes laid due north and south and east and west respectively, combined with the calculations of Moulton [see Abstract 526 (1920)], concluded that there must be an earth tide making up the 0·31 of the calculated amplitude by which the observed result was in defect, and a lag of 4°. It is now shown that these calculations (based on a statistical tide and rigid earth) neglected the effect of potentials due to the earth and ocean tides. The amplitudes and phase displacements of both earth and ocean tides have been recalculated, and eight solutions consistent with

Michelson and Gale's results are found. These are discussed, and five shown to be definitely impossible, while the other three appear to conflict with received theories either by having too great a range or indicating a diurnal ocean tide. The lag of 4° for the earth tide is shown definitely to be an incorrect deduction. C. A. S.

2470. Investigation of Tides of the Red Sea and the Gulf of Suez. (Mrs.) E. Chandon. *Bull. Astronomique*, 6. 1. [99 *pp*.], 1930.

2471. Rayleigh Waves. B. Colombo. *Accad. Sci. Torino, Atti*, 64. 2*a*–6*a*. *pp*. 58–65, 1928–1929.

The propagation of Rayleigh waves in an infinite plane surface of finite thickness is investigated. W. A. R.

2472. Perception of Vibration. K. Suyehiro. *Imp. Acad. Tokyo, Proc.* 5. *pp*. 411–414, *Nov.*, 1929. *In German.*

Experiments are described to determine the boundary between "sensible" vibrations and those that are just not perceived. The limit of sensation does not depend on either the velocity or acceleration alone, but is dependent also in some way on the frequency and the initiating blow. W. A. R.

2473. Bibliography of Seismology. E. A. Hodgson. *Dominion Observat. Ottawa, Publ.* 10. *No.* 2. *pp*. 19–34, *April, May, June, and* 10. *No.* 3. *pp*. 35–47, *July, Aug., Sept.*, 1929.

2474. Depth Attainable by Electrical Methods in Applied Geophysics. A. S. Eve, D. A. Keys and F. W. Lee. *Bureau of Mines, Dept. of Commerce, Techn. Paper* 463. [58 *pp*.], 1929.

The paper gives the results of tests performed in U.S.A. in 1928 over an area containing magnetite, whose magnetic properties were due solely to induction. This ore could be located by magnetic methods and the results used as a check on those from the new electrical methods. The magnetic methods are first employed and the results discussed. A comparison is made of (1) the Gish–Rooney resistivity method, (2) the megger method and (3) the porous pot or volt-ammeter method. In general, taking (1) as standard, the megger results are 16 % low and volt-ammeter results 18 % high. The tests verify the utility and power of the earth resistivity measurements in discovering the presence and depth of conducting bodies or layers underground, and sometimes their thickness, while the use of the megger, a portable instrument for rapid work, is supported. [See Abstract 739 (1929).] R. S. R.

2475. Spectrum of Chromosphere. S. A. Mitchell. *Astrophy. J.* 71. *pp*. 1–61, *Jan.*, 1930.

The material used is derived from the 1905 and 1925 solar eclipses; the spectrum extends from $\lambda 3066$ to $\lambda 7065$; of the flash two plates are given and a table of 3250 lines. The author compares α Persei (type F5) with the chromosphere, whose spectrum he finds to be F0, and there is strong resemblance between the enhanced lines. Line intensities may differ from flash to flash because of differences of level observed, or of solar activity. At present the information most desired is of the lengths of chromospheric arcs as showing heights to which solar vapours extend; these may differ, from the timing of the photograph in or out of the flash, or from the presence of "Baily's Beads" due to solar prominences or lunar mountains. Comparing the 1905 and 1925 spectra: the earlier is better as to definition and was near sunspot maximum, the later was about 1·5 years after minimum, but the lines (especially the green coronium) were much stronger. The red coronium line (which was outside the limit of the 1905 spectrum) was also strong. Under the circumstances it was strange that no single line (out of 100) was higher in 1905 than in 1925; and it is deduced that the chromospheric depth is variable. The greatest heights reached in the chromosphere are 14,000 km. for Ca^+ and 12,000 km. for H_α (hydrogen). A. S. D. M.

2476. Quantitative Spectral Analysis of Solar Atmosphere. V. Ambarzumian. *Zeits. f. Physik,* 60. 3–4. *pp.* 255–268, 1930.

The author describes Milne's hypothesis [see Abstract 2313 (1928)] and shows that taking this as the basis of Unsöld's theory [see Abstract 1200 (1928)] the number of atoms per sq. cm. in Milne's upper layer can be estimated. But in Balmer's series, the lines H_α, H_β, H_γ and H_δ give different numbers, and Struve's work [see Abstract 2710 (1929)] seems to negative Unsöld's explanation of this. The author, therefore, looks in other directions. Transition from the state of monochromatic radiative equilibrium to local thermodynamic equilibrium is conditioned by the want of balance between inelastic and superelastic collisions of atoms and electrons, and different quanta transfers have different probability coefficients when a single series is involved. We find, therefore, for radiation intensity in different lines a different electron partial pressure, and the assumed border between two layers will vary with the spectral lines. The author develops the mathematical theory of the problem, and compares the numerical integrations and equations with observation. Taking the effective atomic number $N = 1$ for H_α, he finds for the four lines of the Balmer series: 1·0, 4·5, 7·8, 10·5, as compared with the observation values [see Abstract 1200 (1928)], 1·0, 3·8, 13, 33. There is still a discrepancy, but less than that given by Unsöld's theory. A. S. D. M.

2477. Effect of Solar Radiation and Interstellar Matter on the Earth's Orbit. H. Greinacher. *Gerlands Beitr. z. Geophys.* 25. 3–4. *pp.* 327–335, 1930.

According to the theory of relativity, the radiation of solar energy causes a decrease of the sun's mass. An increase of the earth's orbit and of the length of the terrestrial year is consequent upon the resultant continual decrease of gravitational attraction. Their respective values are calculated and shown to be very small, but still about four times as great as the effects attributable to the pressure of solar radiation. The resistance offered to the earth's motion by interstellar matter is assumed to be proportional to the square of the earth's velocity, and it is shown that the effect due to this resistance is small compared with the effects due to radiation. J. S. G. T.

2478. Distinction between Scattering and Absorption. J. Q. Stewart and S. A. Korff. *Astrophys. J.* 71. *pp.* 62–69, *Jan.,* 1930.

It has been shown that scattering chiefly produces opacity [see Abstracts 1600 (1928), 2999 (1929), 628 (1930)] in the *Na* vapour D lines, so that light is diverted from the primary beam and scattered (not necessarily with equal intensities) in all directions, the frequency of the radiation remaining unaltered and without transformation into heat. An "artificial planet" is described, and it is concluded that scattering is most important at D-line edges, though absorption of sorts must occur in the cores; when viewed by deflected light instead of by one transmission only, the dark D lines are less intense, for their edges disappear or show up as bright; it is suggested that the diverted radiation is re-emitted in a different wave-length rather than scattered, and it is inferred that there may be possibly more oxygen and water vapour on Mars than has been supposed. The central absorption may be some effect of collisions supplementing the scattering process, but the broadening effect, which should occur [see Abstract 1200 (1928)] from intrinsic lack of tuning at infinite rarefaction, is not found. The authors suggest a process qualitatively capable of producing something like absorption at infinite rarefaction, not dependent on collisions, but on the diffusion in scattering frequency resulting from the Doppler effect of the thermally agitated gas atoms. A. S. D. M.

2479. Deviations from Boyle's Law in Stellar Interiors. H. Jones. *Roy. Astron. Soc., M.N.* 90. *pp.* 293–303, *Jan.*, 1930.

The conditions under which an ionised gas at very high temperatures begins to show a deviation from the perfect gas laws are important in the consideration of stellar structure. It is now possible to calculate the interaction energy of two helium-like ions, obtaining a fairly accurate value of the constant b in van der Waals' equation, and it is this constant which is primarily of interest in the stellar problem. The interaction energy of two ions with nuclear charge Ze is calculated, and the result checked by determination of the diameter of the helium atom at ordinary temperatures. The screening effect of the free electrons is shown to be negligible until very great densities are reached, at which large deviations from the gas laws have already occurred. Finally, an expression is obtained showing explicitly the dependence of b/V on the nuclear charge, the temperature and the density. The large deviations for stars in the lower empty region of the main sequence in Russell's diagram, and the anomalously great diameters for ions with L and M shells, required by Jean's theory of liquid centres, are not confirmed by this investigation. M. A. E.

2480. Spectrum of New Star in Pictor. F. Becker. *Zeits. f. Physik*, 60. 5–6. *pp.* 298–301, 1930.

The paper discusses the spectral characteristics and the intensity relations of certain lines of Nova Pictoris, using objective-prism photographs taken in the spring of 1928, at which time visual observation indicated the formation of a gaseous envelope around the star. The effects of this envelope as evidenced in the spectral photographs are specially dealt with. W. S. S.

2481. Intensity Ratio of Forbidden OIII Lines in Spectra of Planetary Nebulæ and of Novæ. W. Grotrian. *Zeits. f. Physik*, 60. 5–6. *pp.* 302–306, 1930.

An explanation is suggested for the different intensity ratios for the forbidden lines OIII, $\lambda = 4363$, 4959 and 5007, observed in the spectra of planetary nebulæ and novæ respectively. The conclusion is arrived at that the life of the metastable ${}^1S_0$ state of the O^{++} ion must be considerably shorter than that of the ${}^1D_2$ state. W. S. S.

2482. Variation of Space-Velocity of Different Stellar Spectral Types with Absolute Magnitudes. S. Hirayama. *Imp. Acad. Tokyo, Proc.* 6. *pp.* 36–39, *Feb.*, 1930. *In English.*

The material used is Balanovsky's Catalogue of 1488 space-velocities, omitting stellar velocities over 100 km./sec. In each stellar spectral type the absolute magnitudes are tabulated with the corresponding space-velocities. A table and diagram are given which show that the average space-velocity for the same spectral type increases rapidly with average absolute magnitude, but the increase varies very irregularly in the different types; the average space-velocity for giants is less than for dwarfs; and the velocity along the dwarf main sequence increases *from* B *to* M, but the variation is very slow at both extremities, *i.e.*, at B and at K–M types. A. S. D. M.

2483. Radial Velocities of Globular Clusters. P. ten Bruggencate. *Nat. Acad. Sci., Proc.* 16. *pp.* 111–118, *Feb.*, 1930.

This discussion depends on the validity of Strömberg's solution for the sun's motion relative to the globular clusters system [see Abstract 2657 (1925)] with which v. Pahlen and Freundlich are in disagreement; they conclude that the sun moves toward the centre of the clusters group and thus almost at right angles to the direction found by Strömberg. The author develops the equation $\overline{V} = \overline{a}\xi + \overline{b}\eta + \overline{c}\zeta + \overline{V}_s$, where $\overline{V}$ is the mean observed radial velocity and $\overline{V}_s$ is the peculiar radial velocity, and shows that in the case of an unequal distribution over the sky, the mean values $\bar{a}$, $\bar{b}$, $\bar{c}$ will not vanish in general; if $\overline{V}_s = 0$, it is impossible to decide whether the observed negative mean value of $\overline{V}$ is caused by a solar motion in the direction ξ, η or ζ; if $\overline{V}_s \neq 0$, no further investigation can be made by either method, but if the members of the globular clusters have no common stream motion (which is not certain), then Strömberg's solution is the only one possible. Humason and Hubble have shown that spiral nebulæ radial velocities give a linear correlation with distance [see Abstracts 2701 and 2704 (1929)]; and these motions cannot be interpreted as real [see Abstract 76 (1930)], but Zwicky has suggested a reddening in some physical way [see Abstract 975 (1930)]. The author correlates the *red-shift* with distance for the globulars, and suggests three possibilities: (*a*) on the same physical basis as the spirals; (*b*) a dynamic effect; (*c*) a superposition of a dynamic effect on Zwicky's effect. He finds a linear correlation between globular-line displacements corrected for solar motion and galactic latitude, and that it may express a physical relation between the red-shift and the matter between us and the clusters. Such a correlation holds between red-shift and star numbers in cones with solid angles of 60° or larger. This amount of red-shift is of the order given by Zwicky's formula. A. S. D. M.

2484. Fundamental Equations in the Theory of Stellar Evolution. T. Matakuma. *Imp. Acad. Tokyo, Proc.* 6. *pp.* 44–47, *Feb.*, 1930. *In English.*

The author shows that the total energy radiated from the surface due only to contraction is Eddington's potential energy of a star with the sign changed; he develops the fundamental equations [see Abstract 3204 (1928)]: $-c^2 dM/dt = \bar{\epsilon}M = Q$; $-c^2 dM/dt + dE/dt = L$, where L is the total radiation from the surface per unit time, which gives L rigorously, but $Q = \int \epsilon\, dM$ can only be determined approximately. He finds for the early stage of a star that it radiates energy from the surface chiefly through contraction, the effect of mass radiation being negligible; when mass radiation becomes effective, there is still a stage when contraction plays the principal *rôle*, and then evolution proceeds rapidly with some instability in the star's interior; this state may cause Cepheid variation, but the author cannot express it quantitatively. A. S. D. M.

2485. Super-Galaxy Hypothesis. H. Shapley. *Harvard Coll. Obs., Circ.* 350. *pp.* 1–7, *Feb.* 3, 1930.

The galactic system is of a different order from the Milky Way clouds, the Magellanic clouds, local system and external galaxies with diameters ranging from 1 to 40,000 light years. But the groups of galaxies which are distant from us by 1 to 200 million light years, and the diameters of these groups range from 100,000 to millions of light years; the Centaurus group is an example of these super-systems, comparable with our galactic system, which we may look upon as a flattened system of typical galaxies (*e.g.*, the local system or the Magellanic clouds); the obscuring nebulosities are dark rings surrounding some of the component galaxies; the globular clusters are also members of our super-system, but are not genetically connected with the galactic clusters; and the globular high-speed drift is a consequence of the local system motion, so that the galactic nucleus and galactic rotation may need re-interpretation. The author suggests points for research. A. S. D. M.

2486. Computation of Orientation of Great Circle of Asteroidal Search. B. Jekhowsky. *Comptes Rendus,* 190. *pp.* 472–473, *Feb.* 24, 1930.

The author tabulates subjects which will be treated in detail in a forthcoming memoir, and indicates that the most important is that in the computation of the quantity j [see Abstract 2415 (1929)], we are dealing with quantities already known and that these quantities give a single position of the planet. A. S. D. M.

2487. B Stars Motions. J. S. Plaskett. *Science,* 71. *pp.* 225–230, *Feb.* 28, 1930.

Campbell found that B stars have smaller peculiar radial velocities than other classes but have a large positive K term (+ 4·9 km./sec.) as if the B system was expanding with respect to the sun. The author shows that neither personal equation in measurement, errors in wave-length, red displacement of the effective centre of absorption, nor Einstein redward shift of spectral lines in massive stars can account for it; he investigates v. Pahlen's and Freundlich's explanation that it represents a reality, due to very eccentric orbital motions of the stars around a very massive centre, the sun and B stars having just passed the apogalactic point. The present discussion is based on 815 B0 to B5 stars, of which 450 are fainter than those previously used, and their motions have been analysed with particular reference to the theory of galactic rotation. He removes the double-wave rotational term from the radial velocities in addition to the removal of the usual wave solar motion, and he thus finds the true residual velocity (or real K term). He divides the B stars into six main groups of magnitude intervals, 0–5·5, 5·5–6·5, 6·5–7·5, and types B0 to B2 and B3, B5; finding for the four fainter magnitude groups that they give a marked rotational term but an insignificant K term, thus disposing of all the previous explanations that assume its reality. He finds the explanation of the K term in the high positive cluster motions of southern stars mainly between galactic longitudes 240° and 290°, that is, to the brightest and nearest B stars in the Vela–Lupus region; it is not a general characteristic of B stars as a class. A. S. D. M.

LIGHT.

2488. Experimental Investigation on the Absorption Capacity of Substances for Different Wave-Lengths as a Function of Particle Size. G. P. Woronkoff and G. I. Pokrowski. *Kolloid. Zeits.* 50. *pp.* 17–19, *Jan.*, 1930.

In a previous communication [see Abstract 997 (1930)] the authors show that the red colour for HgS suspensions turned to a blue opalescence on a change of mass of the individual particles. Such changes can be observed for particles having a size smaller than $1\,\mu$. Though this effect is relatively weak for polydispersed systems, it is nevertheless possible even for such systems as these to determine the optical properties of individual particle sizes. The theoretical grounds on which the present investigation is based are given, as well as the experimental data obtained for suspensions of HgS and ultramarine in water. J. K.

2489. Distribution of Energy in Composite Colours. J. Malassez. *Comptes Rendus*, 190. *pp.* 521–523, *Feb.* 24, 1930.

Two adjacent surfaces were illuminated, one by a mixture of two monochromatic radiations and the other by a single radiation with a wave-length between the other two until equality of brightness and tint was obtained. The energy flux was measured by a thermopile. If λ_1, λ_2 and λ are the respective wave-lengths, E_1, E_2 and E the energy fluxes, V_1, V_2 and V the visibility factors, then $V_1E_1 + V_2E_2 = VE$. The tests showed that $E_1 + E_2 > E$ in all cases, the retina thus being more sensitive in the explored region to simple light than to composite light of the same tint. The ratio $E/(E_1 + E_2)$ approaches unity as λ approaches λ_1 or λ_2 and is smaller when λ_1/λ_2 increases. R. S. R.

2490. Infra-Red Permeability of Thin Kathodic Films and Organic Substances. E. Rütten. *Zeits. f. Physik*, 60. 1–2. *pp.* 1–12, 1930.

The infra-red permeability of thin kathodic films of selenium, tellurium, carbon, silver and gold are examined between the wave-lengths of 0·8 and $2{\cdot}7\,\mu$. A similar examination is made of gelatin and a number of organic dye-stuffs and other bodies. The substances are examined in the form of thin kathodic layers upon glass. Curves are obtained showing the relation between permeability and wave-length. The metalloids and metals are found to have no great advantage and some defects. It is discovered, however, that a number of dye-stuffs are well adapted to separate parts of the visible spectrum from the infra-red. A black dye-stuff, nigrosine, on gelatin as a carrier, although practically opaque to visible light rays, gives 12·5 % permeability to rays of $0{\cdot}95\,\mu$ wave-length, increasing to 80 % with longer waves ($1{\cdot}7$ to $2{\cdot}6\,\mu$). T. B.

2491. Infra-Red Absorption and Structure of Very Thin Kathodic Metal Films. T. Dreisch and E. Rütten. *Zeits. f. Physik*, 60. 1–2. *pp.* 69–73, 1930.

It is found by the authors that very thin gold and silver films sprayed by kathodic atomisation show colours that differ from thin layers of the pure metal, but are similar to those seen with the colloidal substances in infra-red rays of short wave-length. At a certain thickness of film the colour changes to that which is characteristic of the pure metal. It is demonstrated that this change of colour is due, not to the formation of a compound such as a lower oxide or hydride, but to a change of structure such as a modification from an amorphous to a crystalline phase. Experiments show that the absorption does not depend on the nature of the gas in the apparatus, but on the temperature of atomisation and the thickness of the film. With the thinner films the permeability increases with increasing wave-length; while with the thicker sheets that show the known colours of the metals in transmitted light, the permeability decreases with increasing wave-length, as is the case with pure metals. T. B.

2492. Ultra-Violet Reflecting Power of Aluminium and Several Other Metals. W. W. Coblentz and R. Stair. *Bureau of Standards, J. of Research*, 4. *pp.* 189–193, *Feb.*, 1930.

In this paper data are presented on the ultra-violet reflecting power of aluminium, duralumin, tin and rhodium. The data on aluminium are of special interest in connection with the use of this metal in reflectors of therapeutic lamps. The results of this investigation show that the ultra-violet reflecting power of aluminium compares favourably with that of chromium [see Abstract 2433 (1929)], increasing in reflecting power from about 50 % at 300 mμ to 75 % at 550 mμ. In the visible spectrum the reflectivity is higher than that of chromium. The ultra-violet spectral reflection of duralumin is similar to that of aluminium. Tin has a fairly high reflecting power and may be useful in certain types of echelette gratings. Mirrors of rhodium are best prepared by kathode sputtering. The reflectivity observed on a polished regulus of rhodium increases from about 30 % at 260 mμ to 45 % at 365 mμ. AUTHORS.

2493. Reflecting Power of Some Substances in the Extreme Ultra-Violet. P. R. Gleason. *Am. Acad., Proc.* 64. *pp.* 92–125, *Feb.*, 1930.

Refers to an earlier paper, dealing with reflection of light varying in wave-length from 585 Å. to 1800 Å. [see Abstract 112 (1930)]; the results with three more mirrors are now added, and the apparatus and methods used are described in greater detail. It was found that the arrangement of the molecules in a substance may be of prime importance in determining the value of the reflecting power in the extreme ultra-violet, while the nature of the molecules may determine the shape taken by the reflecting power wave-length curve; the shapes of the curves for crystalline and fused quartz are quite similar, but crystalline quartz is the better reflector for all wave-lengths. The photometric work with oiled photographic plates has shown that the reciprocity condition may be depended on for approximate results, but cannot be used in more accurate work. H. N. A.

2494. Optical Properties of Mixed Crystals. T. F. W. Barth. *Am. J. Sci.* 19. *pp.* 135–146, *Feb.*, 1930.

The object of a theory applicable to mixed bodies is to deduce the properties of the mixture from the proportions and properties of the components. The author discusses the formulæ for the determination of the specific refraction arrived at by various observers, and from the observed results of X-ray examination of the lattice spacings of TlBr–TlI, AgBr–AgI and $BaO.2SiO_2$ and $2BaO.3SiO_2$ arrives at the following conclusions: (*a*) The great deviation shown by the first and last above points to the refractive powers of a mixture being dependent not only on its density, but also on the nature of the chemical bonds, and the degree of deformation of the ions. (*b*) The specific refraction of an ion depends on its surroundings. (*c*) If formation of mixed crystals takes place without deformation of the anions and without changes in the chemical bonds, the refractive indices of the mixtures will vary approximately proportionally to the composition. J. G. H. B.

2495. Anomalous Magnetic Rotatory Dispersion of Solutions. E. Miescher. *Helv. Phys. Acta*, 3. 2. *pp.* 93–133, 1930. *In German.*

Experiments with camphorquinone, and with two other coloured organic compounds exhibiting anomalous rotatory dispersion, showed no signs of anomalous *magnetic* dispersion. Anomalies, similar to the Cotton effect, were observed, however, in the magnetic rotatory dispersion of aqueous solutions of cobalt sulphate, nitrate and chloride, the points of inflexion in the dispersion curves corresponding closely in wave-length with the maxima of selective absorption as recorded by Houston. T. M. L.

2496. Connection Between Intensity and Angle of Deflection in Molecular Scattering of Light. G. I. Pokrowski. *Zeits. f. Physik*, 60. 11–12. *pp.* 850–855, 1930.

It is shown that in the case of the scattering of light through great condensation of the scattering medium an unsymmetrical distribution of the scattered light in relation to the direction of incidence must exist. The theoretical results are compared with the observations on the scattering of light in the atmosphere carried out by Dorno above Davos, and a satisfactory agreement is found. [See Abstract 1843 (1929).] J. J. S.

2497. Production of Diffraction Patterns by Photography of Interference Fringes. G. Simon. *Ann. de Physique*, 13. *pp.* 131–231, *Feb.*, 1930.

Examines both theoretically and experimentally the photographic production of a pattern on a transparent support. Only the obtaining of patterns which give a single order spectrum used for the study of the infra-red are considered, the most simple method consisting of photographing the rectilinear transitions of interference. Daguerre plates give a direct trace on a silver emulsion obtained by reflection, and the Daguerre photographic method is dealt with in detail. In order to obtain a sufficiently extensive pattern, several examinations must be placed in juxtaposition on the same plate. The problem of the juxtaposition is theoretically examined from a consideration of the photographic reproduction of a trace printed on glass. For this correct juxtaposition of the results of tests interferometer methods have been successfully employed. A complete description is also given of the interferometer used, the general installation and the interferometer settings. R. C. F.

2498. Iridescent Colours in Nature from the Standpoint of Physical Optics. (Lord) Rayleigh. *Journ. Sci. Instruments*, 7. *pp.* 34–40, *Feb.*, 1930.

Where insects, or at any rate butterflies, show red colours, these are often due to pigments; but when they show blue colours, these are believed by the author to be in all cases due to interference of light. This fact is shown by experiments. To demonstrate this the author uses the continuous spectrum of hydrogen, and examines the reflection of a blue butterfly in this light. The reflection of chlorate of potash crystals is considered, and the cause of the colour is concluded to be due to repeated reflections from successive twin planes. An iridescent beetle is next examined to see whether it is assimilated to chlorate or the aniline dyes. In comparing the absorptions of some of the iridescent wing cases, tolerably well-defined bands were found. The facts do not fit the theory that the absorption is due to a chemical substance, but everything is explained by interference cutting out certain wave-lengths and causing an absorption complementary to the reflection. Other experiments were carried out on the eye in a peacock's tail feather, but no decisive results were obtained in this instance. T. C. H.

2499. Optical Picture of a Limited Part of a Plane Caused by Rotation. H. Boegehold and M. Herzberger. *Zeits. f. Physik,* 61. 1–2. *pp.* 15–36, 1930.

The authors seek to derive in the simplest possible way the laws for sharp homoplanar and symmetric-planar pictures in the given plane. This picture limits the results of rotation for an axially symmetrical system, and assumes a part of the plane of any selected size perpendicular to the axis and limited to a small pencil of rays. Proceeding from the eikonal of Bruns, different kinds of pictures are treated for a plane perpendicular to the axis. The planar picture is discussed, its differential equations set up and the known cosine law established. Next it is assumed that each point of contact corresponds to a symmetrically rotating caustic. For these symmetric-planar pictures the differential equation is established in continuation of Boegehold's analysis, and the appropriate relation in the cosine form is given. This picture does not give necessarily the usual picture of the plane as does the homoplanar picture of Herzberger, and, finally, it is shown how the homoplanar picture is classified as a special case. [See Abstract 782 (1929).] R. S. R.

2500. Image of an Ultramicroscopic Object in a Microscope with Variable Aperture and Dark Field Illumination when a Disturbing Field with Rotational Symmetry is Present. M. Berek. *Ann. d. Physik,* 4. 3. *pp.* 285–315, *Feb.* 8, 1930.

The complete calculation of the image of an ultramicroscopic particle in a given dark field illumination consists in the combination of two problems: (1) The calculation of the disturbing field which the particle under the influence of the illumination produces. (2) The determination of the intensity ratios in the image space from the given disturbing field on the object side. R. Gans [see Abstract 277 (1926)] has investigated the problem under certain restrictions. Spenke [see Abstract 3014 (1929)] has extended the work of Gans, and found the same expression for the distribution of intensity in the focal plane whatever the obliquity of the illumination. The object of the present paper is to investigate the effect of different disturbing fields in the object space on the intensity distribution in the image space. The paper is entirely mathematical. The conclusion reached is that an ultramicroscopic particle gives as an image a diffraction pattern which even with an aplanatic optical system can differ greatly from the intensity distribution found by Gans and Spenke. T. B.

2501. Optical Glass. E. Berger. *Zeits. f. Instrumentenk.* 50. *pp.* 155–160, *Feb.*, 1930.

Notes on recent progress in the discovery and manufacture of new kinds of glass. Further advances in the direction of new varieties of glass may be expected from the answer to the question: What is the exact reason why some liquids pass over into the crystallised-solid, others into the amorphous-solid condition? J. J. S.

2502. Monocular Micrometer ("M.M.") Universal Theodolite. *Optical Soc., Trans.* 30. 5. *pp.* 261–263, 1928–1929.

The specification is given for an ideal general purpose theodolite intended to be extremely portable, of robust construction, not easy to get out of adjustment, and quickly manipulated. The images of the opposite ends of the circle are seen simultaneously in one eyepiece, and with a micrometer can be read to 1 second. The telescope has internal focussing, and the instrument is provided with electrical illumination for work in the dark. The optical design of the instrument is shown diagrammatically, and a plate provides a general view. [See Abstract 1004 (1930).] R. S. R.

2503. Insensitivity and Personal Equation Errors of Optical Settings. J. Guild. *Optical Soc., Trans.* 31. 1. *pp.* 1–14, 1929–1930.

The paper contains the results of observations on the insensitivity, that is, mean difference of the individual observations of a large series from the mean of the series, in the case of X-type graticules set on vertical object lines. The influence of the following factors was investigated: (1) thickness of cross-wires; (2) angle between cross-wires; (3) field brightness; (4) pupillary aperture. Observations were also made of the magnitude of the "personal equation" error in such settings. AUTHOR.

2504. Intense Source of Continuous Ultra-Violet Light. E. O. Lawrence and N. E. Edlefsen. *Rev. Sci. Instruments,* 1. *pp.* 45–48, *Jan.*, 1930.

Description of a hydrogen discharge tube having a maximum discharge of 6·5 A. at 3000 V. Two cylindrical aluminium electrodes, 6 cm. diameter and 40 cm. long, fit into vertical pyrex tubes. The two large pyrex tubes are joined by a quartz tube 7 mm. and 60 cm. long. Jets of water are played on to the joints, and the whole apparatus is immersed in a tank of water. The discharge is viewed "end on" through a quartz window waxed on to a pyrex side tube protruding through the wall of the tank. Experiments suggest that the intensity at constant discharge current does not vary greatly over the range from the near ultra-violet to 2000 Å. The intensity of the light in the continuous spectrum varied linearly with the discharge current over the range 1 to 5 A. W. C. S. P.

2505. New Flicker Radiometer. D. C. Stockbarger and L. Burns. *Rev. Sci. Instruments,* 1. *pp.* 76–83, *Feb.*, 1930.

When radiation is allowed to pass alternately through one and the other of two filters having identical transmissions for all wave-lengths except those lying in a narrow spectral region, a flicker is produced which is a function of the intensity of the radiation within that region. A radiometer making use of this principle is described in detail. The filters are cut in the shape of sectors, and are so arranged as to form a solid wheel. The filtered radiation passes through a window into a magnesium photoelectric cell fabricated of Vita glass. Oscillograms show that the a.c. component of the photoelectric current, after electrical filtering and amplification, is sinusoidal. AUTHORS.

2506. Twentieth Annual Exhibition of the Physical and Optical Societies. *Journ. Sci. Instruments,* 7. *pp.* 68–73, *Feb.*, 1930.

Notes on Exhibits: "Optical Instruments," by **W. B. Coutts**; "Microscopes," by **D. J. Scourfield.**

2507. Polarising Apparatus for Determining Extinction Angles. E. E. Jelley. *Journ. Sci. Instruments,* 7. *pp.* 96–99, *March,* 1930.

A polarising apparatus enabling the ordinary biological microscope to be used for accurate determination of the extinction angles of microcrystals is described. AUTHOR.

2508. Camera for Aerial Photography. *Rev. d'Optique,* 8. *pp.* 486–495, *Dec.*, 1929.

Describes in detail the construction and use of the aerial photographic camera "Planiphote." The characteristics of this camera are: useful size of image 165 × 245 mm., Pathé film used, capacity of 200 photographs, the film being changed during flight, overall dimensions 32 × 30 × 52 cm., weight 26·5 kg., objective with a focal length of 30 or 50 cm. and a stop of *f*/4·5 or *f*/5·7, Labrély type shutter used, camera operated automatically or by hand. The four principal parts of the camera described are the camera case and distributor mechanism, the magazine, the control arrangements and the suspension. R. C. F.

2509. Reduction and Intensification of the Image by Development in Bright Light. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 27. *pp.* 305–311, *Feb.*, 1930.

Gives results illustrating the reduction of the latent image by illumination with red light after impregnation with the desensitiser. Long exposures to red light have a strong destroying action. Green illumination of a plate still wet from desensitisation with pynakryptol green or yellow is shown to produce a strong intensification of the image. Finally, a discussion of the results for red after-illumination is given, particularly with reference to the Sterry effect and a possible comparison therewith. R. C. F.

2510. Metallic Silver in Undeveloped Photographic Layers, Part I. F. Weigert and F. Lühr. *Zeits. f. wiss. Phot.* 27. *pp.* 312–336, *Feb.*, 1930.

Earlier results of Schoeller, Schubert and the present authors, which have indicated rather high silver values for non-illuminated silver halide-gelatin emulsions, are further examined. Certain considerations are given which indicate that the previous identification of this silver value as metallic silver is erroneous. A further examination of these earlier investigations is, therefore, carried out, in which a new fixation method is used, by means of which the last traces of silver thiosulphate are almost completely removed. The results obtained indicate a somewhat lower silver value than previously obtained, the principal phenomena being, however, completely confirmed. It is also proved by treatment with persulphate that the silver value obtained for the fixed plates is definitely due to metallic silver and not to silver sulphide. R. C. F.

2511. Actinity and Colour Temperature of Magnesium Ribbon Burning in Air and Flash-Light Powder. J. M. Eder. *Zeits. f. wiss. Phot.* 27. *pp.* 337–343, *Feb.*, 1930.

Gives results of new estimations of the actinity and colour temperature of magnesium ribbon and flash-light powder. One mg. of magnesium burning in air is found to have an activity of 413 m. sec. candles with relation to silver bromide-gelatin emulsions. Flash-light powders which are mixtures of magnesium powder and nitrates have a lower actinic value, *e.g.*, 200–300 m.sec. candles, than pure magnesium, whilst magnesium ribbon burning in oxygen possesses an activity of 770 m.sec. candles. The colour temperatures obtained are magnesium ribbon 3700° K. in air, approx. 4000° K. in oxygen, and only 3000°–3100° K. for flash-light powder containing thorium nitrate. R. C. F.

2512. Sensitisation of Photographic Plates and Photography of Different Spectra in the Near Infra-Red. P. Lueg. *Zeits. f. Physik*, 60. 1–2. *pp*. 13–19, 1930.

Accurate investigation of the near infra-red spectrum is limited by the non-sensitivity of photographic plates, for long exposures are necessary and large dispersions cannot be used. Sensitising with dicyanine is unsuitable, whilst strong hypersensitisation usually involves the loss of faint lines due to fog. Neocyanine possesses many advantages; its sensitising region commences at 6000 Å., is a maximum at approximately 8600 Å., and decreases rapidly to 9000 Å., and no fog occurs with hypersensitisation. Two formulæ are given which are suitable for sensitising plates up to 9000 Å., and with a dispersion of 2·6 Å./mm. only a maximum of 30 min. exposure is necessary. Absorption measurements up to 1μ are possible by the use of sensitised Schumann plates, and the method of obtaining these plates from commercial plates is described, 12 hours' exposure, however, being necessary. Means of improving the emitting sources in order to enable reduced exposure times to be used are briefly described, examples of spectra obtained being given. R. C. F.

2513. Origin of Mercury Bands. S. Mrozowski. *Zeits. f. Physik*, 60. 5–6. *pp*. 410–413, 1930.

In continuation of previous work on intensity distributions in the absorption and fluorescence bands of mercury vapour [see Abstracts 3318 (1929) and 594 (1930)], the author shows that atomic processes, while playing no primary part in the excitation of these bands, still do take an important part in their production. J. S. G. T.

2514. Extinction of Sodium Fluorescence by Foreign Gases. J. G. Winans. *Zeits. f. Physik*, 60. 9–10. *pp*. 631–641, 1930.

An investigation into the effect of adding Br_2, CO_2, N_2, A, H_2 and He–Ne mixture on the fluorescence of Na vapour (in NaI and NaBr vapours). The extinction effect was greater with those gases which react chemically with Na, Br_2 and CO_2, than with those which do not, A and H_2, etc. Assuming that the extinction effect is due to collisions of the sodium atom with the atoms of the foreign gas, values are obtained for the joint collision distance with the various gases. With H_2 the collision radius of the sodium atom appears to be independent of its velocity. With Br_2 the collision radius is greater with decreasing velocities. The values of the collision radii with H_2 and N_2 are appreciably smaller than those obtained by Mannkopff [see Abstract 1567 (1926)]. J. E.

2515. Deformed Eigen-Value Spectra. E. Schrödinger. *Preuss. Akad. Wiss. Berlin, Ber*, 31. *pp*. 668–682, 1929.

A theoretical paper discussing the relation of the eigen function to spectral theory by wave mechanics. F. S.

2516. New Effect of Light upon Matter. Interpretation of the New Ponderomotive Effect of Light. V. Pospíšil. *Phys. Zeits.* 31. *pp.* 65–78, *Jan.* 15, and *pp.* 447–450, *May* 1, 1930.

Experimental evidence that the absorption of light is able to increase the magnitude of Brownian motion is presented and discussed. An interpretation of the effect based on the hypothesis of the quantum absorption of light and its conversion, wholly or in part, into kinetic energy of the absorbing particle is developed. [See also Abstract 2662 (1927) and following Abstract.] J. S. G. T.

2517. Radiation [Nadelstrahlung] and Brownian Motion. V. Pospíšil. *Phys. Zeits.* 31. *pp.* 78–80, *Jan.* 15, 1930.

The small increase of Brownian motion to be anticipated from the absorption of light by a particle suspended in a viscous medium is discussed mathematically. The effect to be expected, on theoretical grounds, is extremely small, and very much smaller than that actually observed. [See also preceding Abstract.] J. S. G. T.

2518. Anomalous Dispersion in Band Spectra. E. Segrè. *Accad. Lincei, Atti,* 10. *pp.* 590–594, *Dec.* 1, 1929. **N. Cimento,** 7. *pp.* 144–147, *April,* 1930.

The absorption spectrum of iodine vapour at a temperature slightly above that of the atmosphere between 5100 and 5800 Å. exhibits bands with a festoon structure. From the relation between refractive index and the number of dispersion electrons corresponding with any particular wave-length, an expression is derived for this structure. The available data do not allow of even an approximate evaluation of the total number of dispersion electrons. T. H. P.

2519. Absorption Spectra of the Azobenzene Crystal. J. W. Obreimow and W. J. de Haas. *K. Akad. Amsterdam, Proc.* 32. 10. *pp.* 1324–1328, 1929. *Comm. No.* 204*c from the Phys. Lab., Leiden.*

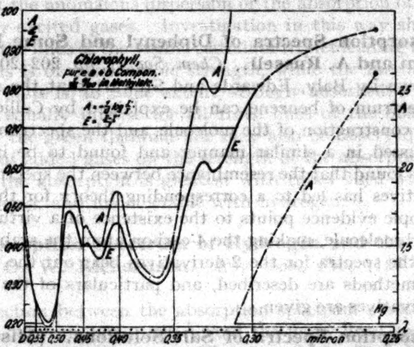
It has been shown previously [see Abstract 3223 (1928)] that the change of colour of crystals at low temperatures is a general phenomenon for all crystalline bodies and that at low temperatures the absorption spectra of all crystals must probably be line spectra, the wide absorption band of most of the well-known crystals splitting up into fine lines like the bands of the rare earths or the wide bands of benzene. At 20° K. and lower temperatures azobenzene shows a line spectrum when the light vector is parallel to the *b*-axis (red spectrum). Spectral photographs in the first order of the grating have been taken at 14° K. and 4·22° K., all but two of the forty-two measured lines fitting into a series scheme consisting of several series of equidistant lines: 0, 0′, 0″, 1, 1′, 1″, 1‴, 2, 2′, 2″, 2‴, 3′, 3″. The mean distance between two consecutive lines of the 0, 1, 2 or 3 group is 199·26 in wave-numbers, and the mean distance between the first lines of two neighbouring groups 652·2. The spectrum may, therefore, be represented by the formula, $\nu = \nu_0 + am + bn$, where m and n are the whole numbers 0, 1, 2, 3, and ν_0, a and b have the constant values 18,178, 199·3 and 652·2 respectively. The microphotogram of the spectrum of azobenzene at 4·22° K. shows that the spectrum is more complicated than is indicated above, diffuse bands existing with the sharper lines to form a continuous background. Investigation of the absorption spectrum for the component of the light perpendicular to the *b*-axis reveals no structure in the spectrum, even at 4·22° K., continuous absorption in the violet without discrete bands being observed. T. H. P.

2520. New Group of Bands in the Ultra-Violet Absorption Spectrum of Selenium Vapour. (Miss) M. Moraczewska. *Acad. Polonaise Sci. et Lettres, Bull.* 1–2*a*. *pp.* 17–19, *Jan.–Feb.*, 1930. *In German.*

An absorption tube 130 cm. long and made of quartz with plane parallel end plates of the same material was used in an electric oven to obtain the absorption spectrum of Se vapour. The Se was purified by repeated distillation *in vacuo* before being introduced into the tube, which could be maintained at temperatures between 200° and 400° C. A new group of bands was found in the region 2300–2100 Å. Like other Se bands, the new ones are shaded off towards the red. They are represented approximately by the formula $\nu = 43{,}210 + 368n - 0{\cdot}2n^2$, the wave-length of the head of the system being 2295 Å. The conditions of the experiment tend to the conclusion that the carrier for this spectrum is not Se_2, but probably a multi-atomic molecule. Further experiments under different conditions may throw light on this question. A. W.

2521. Ultra-Violet Absorption Spectrum of Chlorophyll. D. van Gulik. *Ann. d. Physik*, 4. 4. *pp.* 450–452, *Feb.* 24, 1930.

As source, the continuous spectrum of a glowing tungsten strip in a quartz bulb was employed together with the line $0{\cdot}254\,\mu$ of the mercury-vapour lamp for the extreme point in the range. The chlorophyll was pure, consisting of the *a* and *b* components together, and the solvent methyl or ethyl alcohol. The results are given in the above diagram, where E represents the percentage absorption and A the absorption constant. It is seen that the so-called end-absorption does not set in until about $0{\cdot}35\,\mu$. W. S. S.



2522. Absorption of Light by Nitrophenols. Part I. In Weak Alkaline Aqueous Solutions. Part II. In Acid and Organic Solvents. Part III. In Concentrated Salt Solutions and Lyes. J. Eisenbrand and H. v. Halban. *Zeits. f. phys. Chem.* 146. *Abt. A.* 1. *pp.* 30–40, *Jan.*, and 146. *Abt. A.* 2. *pp.* 101–130, *Feb.*, 1930.

Plotting the (logarithmic) extinction coefficient ϵ against the wave-length (250–500 $\mu\mu$), the authors distinguish between primary, secondary and tertiary effects according to the order of magnitude of the change in ϵ, 1 to 1000, 1 to 10 and 1 to $1{\cdot}6$, produced by a change in the constitution when the change from mono- to di- and tri-phenolate (picrate) and back

is studied. In Part I, where the phenol concentration is about 10^{-4} and the NaOH concentrations 10^{-3}, the changes from mono- to di- and from tri- back to di- affect ϵ considerably, but not the changes from di- to tri-, and from di- back to mono-phenolate. The introduction of a second and third NO_2 group has a noteworthy effect only when this involves a change of the NO_2 relative to the OH group. But none of these changes is of more than secondary order. Part II. Similar relations hold for acid solutions, and there are considerable differences in the absorptions of nitro-anisols and undissociated nitrophenols. The first band is to be ascribed to the nitro group, the second to the benzene nucleus. The acids tried were HCl, H_2SO_4 and $HClO_4$. Part III. In concentrated solutions of salts (alkali chlorides) and alkali (NaOH), that is, at higher electrolytic concentration, the changes become greater. In salt solutions the changes are only displacements of the bands. In alkaline solutions, however, the changes go deeper, and the above relations no longer hold. They are stronger for the di- than for the mono-phenol; the two di-nitrophenols ($o - o$ and $o - p$) of about equal dissociation constant 10^{-4} give similar spectra; picric acid, the strongest of these acids, stands apart from the others, and shows a new band and a second dissociation constant of the order 10^{-15} or 10^{-16}, probably connected with the capacity for forming molecular compounds.
H. B.

2523. Absorption Spectra of Diphenyl and Some Derivatives. T. C. C. Adam and A. Russell. *Chem. Soc., J. pp.* 202–206, *Feb.*, 1930.

It was shown by Baly, Edwards and Stewart that the seven-banded absorption spectrum of benzene can be explained by Collie's oscillation theory for the construction of the molecule, and the spectrum of naphthalene was discussed in a similar manner and found to be in agreement. The author has found that the resemblance between the spectra of diphenyl and its derivatives has led to a corresponding theory for this substance. The spectroscopic evidence points to the existence of a virtual para bond in the diphenyl molecule, making the 4-carbon atom the stable member of the ring, and the spectra for the 2-derivatives bear out the theory. The experimental methods are described, and particulars of the spectra of a number of derivatives are given.
J. G. H. B.

2524. Absorption Spectra of Salt Solutions. (Miss) S. Kato. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 225. *pp.* 230–250, *Feb.* 20, 1930. *In English.*

The absorption spectra of salts of nearly fifty elements have been analysed, using a constant deviation and a small quartz spectrograph, and the problems relating to absorption by ions are discussed. Kations are divided into two groups—those which give no absorption and those which absorb in the quartz region. The former assume definite valencies and are stable in solution, while the latter have variable valencies and are unstable in solution. Absorption spectra due to halogen anions are discussed as "affinity spectra," those due to solvated and hydrated ions as well as non-hydrated gaseous ions having been observed with various solutions.
F. S.

2525. Absorption Spectra of Strong Electrolytes in Concentrated Solutions. Tetra-Alkyl-Ammonium Nitrates. H. v. Halban and J. Eisenbrand. *Zeits. f. phys. Chem.* 146. *Abt. A.* 3–4. *pp.* 294–308, *Feb.*, 1930.

This paper continues a previous investigation [see Abstract 126 (1929)], and describes the absorption spectra of tetra-alkyl ammonium nitrates (tetra-ethyl, tetrapropyl) in aqueous and chloroform solutions in the region of the long-wave ultra-violet bands. The spectrum of the solutions in chloroform shows the bands to be scarcely changed in form, but considerably displaced towards the red. A like displacement takes place in both aqueous and methyl alcohol solutions. The Beer law is found valid in both chloroform and methyl alcohol solutions. The possible causes of these displacements are discussed. H. H. Ho.

2526. Atmospheric Oxygen Band at λ7600 (A-Group). R. M. Badger and R. Mecke. *Zeits. f. Physik,* 60. 1–2. *pp.* 59–68, 1930.

The band was photographed in absorption, using a continuous light source and a grating spectrograph. A discussion of the combination relations confirms the correctness of Mulliken's assignment of a $^1\Sigma - {}^3\Sigma$ intercombination. F. S.

2527. Absorption of Electrically-Excited Vapours of Cadmium, Zinc and Thallium. G. Hoffmann. *Zeits. f. Physik,* 60. 7–8. *pp.* 457–463, 1930.

The existence of metastable atoms is capable of experimental proof by observation of the anomalous dispersion or the absorption of light traversing electrically-excited gases. Investigation in this way shows that the absorption of the lines of the visible cadmium triplet leading to the metastable conditions is of considerable strength, while the line leading to the unstable 2^3P_1 state is, to some extent, strongly absorbed. With zinc the absorption is equally intense for all three lines of the observed triplet. Absorption of the green thallium line may also be observed. As regards the influence of added gases on the strength of the absorption in the case of cadmium, the absorption is greatest with tubes filled with rare gases, less with nitrogen, and undetectable with hydrogen. T. H. P.

2528. Absorption Spectrum of Hydrogen and the Many-Lined Spectrum. O. W. Richardson. *Roy. Soc., Proc.* 126. *pp.* 487–510, *Feb.* 3, 1930.

The connection between the absorption spectrum observed by Dieke and Hopfield between 1000–1500 Å. and the many-lined spectrum is discussed and new bands ending on $2p\Pi_{a,b}$ described. The electronic levels of H_2 are considered in detail, and also the rotational structure and final rotational levels. F. S.

2529. Multiple-Line Spectrum of Hydrogen. P. Das. *Zeits. f. Physik,* 59. 3–4. *pp.* 243–253, 1930.

The case of hydrogen presents the simplest form of a molecular model based on the system of Franck and Jordan for the explanation of the mechanism of molecular dissociation, but, in this instance, to explain the existence of the series lines and the so-called P-, Q-, R-groups of the band spectrum of hydrogen. The author developed the model in 1923, and from it he now calculates the energy conditions according to wave mechanics, and gives a full interpretation of the precise meaning of the constitution of the groups in the band spectrum of hydrogen mentioned above. The paper is mathematical throughout, and the results of theory are calculated and compared with those of experiment by other observers with satisfactory accuracy and agreement. S. G. B.

2530. Continuous Hydrogen Spectra. D. Chalonge and N. T. Zé. *Comptes Rendus*, 190. *pp*. 425–427, *Feb*. 17, 1930.

The effect of pressure has been investigated and it is concluded that higher pressures, about 20 mm., conduce to the excitation of continuous spectra due to atoms instead of molecules and associated with the Balmer and Paschen series respectively. F. S.

2531. Lyman's Helium Spectrum. F. Paschen. *Preuss. Akad. Wiss. Berlin, Ber*. 30. *pp*. 662–666, 1929.

Measurements in the Lyman region have lately been improved owing to the comparison of short-wave lengths in higher orders with known wave-lengths in lower orders, and several spectra, such as Al II and HgII, have been analysed sufficiently to determine the basis of their term-systems. In the present paper the spectra of HeII and HeI are discussed in this way, using the results obtained by Kruger with a vacuum grating spectrograph of 1·5 m. radius. F. S.

2532. First Spark Spectrum of Mercury, HgII. G. Déjardin and R. Ricard. *Comptes Rendus*, 190. *pp*. 427–429, *Feb*. 17, 1930.

Comparison of Paschen's results with those indicated by the spectrum of electrodeless discharge. The spectrum of HgIII is discussed as a necessary preliminary to that of HgII. F. S.

2533. Relative Intensities of Super-Multiplet Lines. J. H. Bartlett, Jr. *Phys. Rev*. 35. *pp*. 229–234, *Feb*. 1, 1930.

A simple method is described by which one may construct wave functions for the case of (jj) coupling. The wave functions for $(2p)^2$, so determined, agree with those given in a previous paper [see Abstract 1398 (1930)] when one sets the electrostatic interaction equal to zero. It is shown how the ordinary multiplet intensity formulæ may be modified to give the relative intensities in a super-multiplet for (jj) coupling. The modified formulæ, applied to the transition $(2p)^2 \rightarrow 2p3s$, give relative intensities in agreement with those found in the above paper, for this limiting case. The sum-rules hold quite generally for non-equivalent electrons, and it is shown to what degree they hold for a transition such as $(2p)^2 \rightarrow 2p3s$.

AUTHOR.

2534. Extension of the Spectrum of Thalluim, Tl II. S. Smith. *Phys. Rev*. 35. *pp*. 235–239, *Feb*. 1, 1930.

The spectrum of singly ionised thallium has been obtained by using the metal in a hollow kathode discharge in helium. Spectrograms have been made from 1900 Å. to 8000 Å. The newly found terms here reported are $6s8d\,{}^3D_{1,2,3}$, $6s8d\,{}^1D_2$, $6s9s\,{}^3S_1$, $6s10s\,{}^3S_1$, $6s6f\,{}^3F_{2,3,4}$, $6s7f\,{}^3F$ and an unclassified term 2_3^0. Absolute term values have been calculated from the sequence $6s6d\,{}^3D_2$, $6s7d\,{}^3D_2$, $6s8d\,{}^3D_2$. The ionisation potential is found to be 20·30 volts. Tables of term values and of about sixty newly classified lines are given. Fourteen new multiplets arising from the fine structure of the terms are also tabulated. AUTHOR.

2535. Sodium and Magnesium Spark Lines in the Far Ultra-Violet, and the Quantitative Application of the Irregular Doublet Law to Isoelectronic Sequences. J. E. Mack and R. A. Sawyer. *Phys. Rev*. 35. *pp*. 299–308, *Feb*. 15, 1930.

New levels in NaIII, MgIV and MgV are identified through the transition $2s \leftarrow 2p$. The value of the negative term $2s2p^5\,{}^3P$ of O I is predicted.

The relativistic screening number $\sigma_2(L_{21}L_{22})$ is 3·19 for Z = 10, 11 compared with the value 3·49 for heavier atoms, usually considered independent of Z. The difference is probably due to outer screening. Wentzel's result $\sigma_1(n, l+1) - \sigma_1(n, l) = 0 \cdot 58 \times 2^l n$ for the first order screening number σ_1 in X-rays is applied instead of the usual qualitative form of the irregular doublet law to determine the rate of dependence of the transition energy $2s^2 2p^5 \leftarrow 2s 2p^6$ upon Z in the fluorine-like isoelectronic sequence. The extremely high result, 49×10^3 cm.$^{-1}$, is verified by the new NaIII and MgIV data. Certain regularities in the curves showing the rates of dependence of the irregular doublet transition frequencies upon the atomic number in isoelectronic sequences, as functions of the number of electrons present, may be used for interpolation of these rates. AUTHORS.

2536. New Measurements in the Fourth Positive CO Bands. R. S. Estey. *Phys. Rev.* 35. *pp.* 309–314, *Feb.* 15, 1930.

That part of the fourth positive system of CO lying between 1970 Å. and 2800 Å. has been remeasured together with sixteen bands not previously observed. An equation for the band heads is given, the constants of which yield the values D′ = 12·00 volts, D″ = 11·17 volts for the heat of dissociation. Modifications in values of frequency have been small, while those of intensity have been rather large. Some discrepancies have been removed. Revision of intensity estimates permits a far more accurate comparison than previously with Condon's theory of intensity distribution and shows the superiority of Morse's U (*r*) function. Using this function, the distribution of intensity among the bands of the fourth positive system agrees perfectly with Snow and Rideal's value of the moment of inertia for the normal state, $I_0'' = 15 \cdot 0 \times 10^{-40}$ g.cm.^{2} The quantum assignment of Asundi's infra-red electronic bands has been revised. AUTHOR.

2537. Fine Structure of Beryllium Fluoride Bands. F. A. Jenkins. *Phys. Rev.* 35. *pp.* 315–335, *Feb.* 15, 1930.

New wave-length measurements have been made of the bands at $\lambda\lambda$3009·5 – 3026·3, $\lambda\lambda$2908·9 – 2927·8 and $\lambda\lambda$3126·1 – 3140·8, which include all the stronger lines of the (0, 0), (1, 0) and (0, 1) bands. The source was a cored carbon arc, and a 21-ft. grating was used in the second order. The wave-numbers of the lines in the six branches of each band are tabulated for rotational quantum numbers up to about K = 50 in the R branches, 45 in the Q branches and 30 in the P branches. The term "analysis of the bands" is discussed and equations representing all the lines in a given band are deduced. A list of the more important molecular constants is also given. F. S.

2538. Iodine Spark Spectrum. W. Kerris. *Zeits. f. Physik*, 60. 1–2. *pp.* 20–42, 1930.

Measurements of the spark spectrum of iodine between 7486 Å. and 2562 Å., obtained from Geissler tubes and taken on a Rowland grating spectrograph, are given. A comparison is made between the present author's results and those of Wood and Kimura between 7468 Å. and 4632 Å., below which the comparison is between the results of the present author and those of Kohnen, and Exner and Haschek. A table of arc lines by other authors is also included. Finally, a table of comparison of the lines with fine structure, due to Wood and Kimura, and the present author, is given. R. C. F.

2539. Intensity Distribution in Diffraction Spectra. P. H. Brodersen. *Zeits. f. Physik,* 60. 1–2. *pp.* 43–58, 1930.

The effects due to adjustment and to the light source upon the distribution of intensity among the lines on grating spectrograms are investigated, with special reference to the secondary normals in the iron arc where it is of importance. A general property of gratings is to make lines appear manifold with extrafocal adjustment. It was also attempted to correlate line displacement with adjustment of the source using a microphotometer, but this cannot in general be done with security. F. S.

2540. Spectrum of Boron Monoxide. W. Scheib. *Zeits. f. Physik,* 60. 1–2. *pp.* 74–108, 1930.

Three spectra of boron are known; one spark spectrum and two band spectra. Of the latter one is obtained by feeding solid boric acid into a bunsen flame; it consists of a row of widespread maxima, which in particular are very strong in the green. The other band spectrum was obtained in the region 3600 to 7000 Å. by the author through the abundant supply of crystallised boric acid to a 220-volt arc between two very thin carbon poles drawn as far apart as possible. At first " heads " appeared to be missing, but at higher magnification the series of lines was seen to proceed from two neighbouring heads of strong intensity, and that other series of fainter lines converged to the same places. These heads were double, so that actually there are four heads to each system; and a comparison with Millikan's measurements of the boron-monoxide spectrum shows the complete identity of the two spectra, and the B–O molecule can be regarded with certainty as the carrier of both. The spectrum of the B–O molecule consists of three systems, the α-bands already mentioned, each with two double heads, between wave-lengths of 12,000 to 3100 Å., the β-bands with single heads from 3700 Å. to 2100 Å., and the combination-bands which lie under the α-bands, and in contrast to the α- and β-bands are shaded off towards the violet. The similarity in structure between the B–O spectrum and those of N–O and C–O is pointed out, and is attributed to the presence of three external electrons in each of the molecules. It is also noted that the lines which indicate the existence of boron in the sun belong to the boron-monoxide spectrum. T. B.

2541. Spectra of Fe, Na, Ca, Ba, Sr, Mg and their Compounds in the Near Infra-Red. Johanna Querbach. *Zeits. f. Physik,* 60. 1–2. *pp.* 109–124, 1930.

The spectra from 7000 Å. to 9000 Å. were photographed with a 6·4 m. grating. Some new iron lines of intensity 1 were found, and also new band spectra due to Ca, Sr, Mg and Ba. The latter were arranged as combinations of a new ^2X-term with Johnson's 2^2S-term. An intercombination band 2^2S–3^2D_2 was measured, and four new band systems of lanthanum oxide. F. S.

2542. Secondary Standards in the Iron Spectrum Between 3600 and 3000Å. H. Pressentin. *Zeits. f. Physik,* 60. 1–2. *pp.* 125–136, 1930.

Nineteen lines in the violet and near ultra-violet have been measured to an accuracy of 0·001 Å. by interferometer methods, taking the cadmium red line as fundamental standard. The precautions necessary to obtain reproducibility in the lines of the iron spectrum are also considered.

J. H. A.

2543. Band Spectrum of Lithium Hydride. W. Weizel. *Zeits. f. Physik*, 60. 9–10. *pp.* 599–602, 1930.

This is a discussion of Nakamura's results for the LiH spectrum. The upper term is now designated as a $p\sigma^1\Sigma$-term, and notable anomalies of the terms are elucidated as due to an *l*-uncoupling. F. S.

2544. Number of Dispersion Electrons in Sodium and Lithium Vapours. B. Trumpy. *Zeits. f. Physik*, 61. 1–2. *pp.* 54–60, 1930.

Describes several calculations performed on the line intensities of the series lines of sodium and lithium, the calculations being extended to the fifth term in the principal series of these elements. The theoretical *f*-values obtained agree with the previously observed values within the limits of experimental error. [See also Abstract 1463 (1930).] R. C. F.

2545. Spectrum of Silicon Hydride. C. V. Jackson. *Roy. Soc., Proc.*, 126. *pp.* 373–392, *Feb.* 3, 1930.

The most favourable conditions for the production of the 4100–4200 Å. band were found. The spectrum has been investigated under high dispersion, and wave-length measurements have been made. The band has been analysed and found to consist of doublet P, Q and R branches which show σ-type coupling. The double origin is at $\nu = 24102$ cm.$^{-1}$ and 24226 cm.$^{-1}$ The (0,0) band and the Q branch of the (1,1) band were found to be present. Some perturbations were found in the rotational structure, which are shown to arise in the final state of the molecule. The electronic transition is shown to be $^2D \rightarrow {}^2P$, and the ^2P level is inverted. The carrier of the spectrum is considered from theoretical and experimental reasons to be SiH. F. S.

2546. Infra-Red Emission Bands. M. Neunhoeffer. *Ann. d. Physik*, 4. 3. *pp.* 352–356, *Feb.* 8, 1930.

Obtains the emission intensity curve of the H_2O band at $1 \cdot 8\,\mu$ by means of an accurate reflection grating and a thermo-junction. The fine structure of this band is shown to be similar to that occurring at $2 \cdot 7\,\mu$, although this is not to be expected from the edge scheme developed by Hettner. [See also Abstract 166 (1930).] R. C. F.

2547. Experimental Laws of the Raman Effect. J. Cabannes. *Rev. d'Optique*, 8. *pp.* 461–485, *Dec.*, 1929.

Gives the laws of the Raman effect in an attempt to place the new effect among those already known for diffusion, fluorescence and optical resonance. A monochromatic radiation after diffusion by any transparent medium whatsoever ceases to be monochromatic. The incident ray is widened by diffusion and displaced towards the longer wave-lengths, whilst it also becomes enclosed on both sides by a continuous spectrum. New rays and bands usually appear in the spectrum of the diffused radiation. The difference, either positive or negative, between the frequency of the exciting radiation and that of a Raman ray is intimately connected with the medium and not with the exciting radiation. All the negative secondary rays characterised by a similar decrease in frequency have the same intensity in relation to the ray diffused without frequency change, the same length, dissymmetry and state of polarisation. The intensity of a ray, positive to the exciting ray, is also less than that of the corresponding negative ray, this intensity difference increasing with increase of divergence from the exciting radiation. To the first approximation the intensity of the Raman rays is proportional to the number of molecules in unit volume whatever the physical state of the material, whilst a number of these rays can be connected with well-defined atomic groups, this last being of importance in the determination of molecular structures. R. C. F.

2548. Raman Effect. A. C. Menzies. *Nature*, 125. *pp.* 205–207, *Feb.* 8, 1930.

A summary of the work carried out on the Raman effect since its discovery by C. V. Raman [see Abstract 2368 (1928)].

2549. Raman Effect Near Critical Point. S. L. Ziemecki and K. Narkiewicz-Jodko. *Phil. Mag.* 9. *pp.* 299–305, *Feb.*, 1930.

From experiments using a photographic method on the liquid isobutyric acid it is concluded that the Raman spectrum exists at the critical point, and its intensity remains unchanged by the critical opalescence. The previous results of Bogros-Rocard and Martin are satisfactorily explained, and it follows from the work that a fundamental difference exists between Raman effect and scattered radiation, and that on an experimental basis the new radiation may be called incoherent, whereas the classical scattering is coherent. W. H. Ge.

2550. Theory of Molecular Light Scattering in Crystals. L. Mandelstam, G. Landsberg and M. Leontowitsch. *Zeits. f. Physik*, 60. 5–6. *pp.* 334–344, 1930.

The light scattering is treated as a diffraction of the elastic vibrations in the crystal, treating the crystal as a classical continuum by the Debye method. In the scattering the frequency of the light is altered by ω_0, where ω_0 is the frequency of the elastic vibration under consideration. If the vibration belongs to the acoustical spectrum of the crystal, the alteration in frequency is naturally small, and it is also dependent on the direction of scattering. When the vibration is part of the infra-red spectrum, the alteration in frequency is much greater, and is practically independent of the direction of scattering. The calculation leads to a formula for the ratio of the intensities of the scattered and incident light. This formula is then modified so as to account for polarisation observations made by Cabannes [see Abstract 1858 (1929)] and Menzies [see Abstract 1039 (1930)]. The writers believe that these observations point to the existence of dipoles in quartz, which in equilibrium have the direction of the optic axis, but ordinarily, through the heat motion of the crystal, have an oscillation about this mean position, with an infra-red frequency. A. C. M.

2551. Quantum Theory of Molecular Light Scattering in Solids. I. Tamm. *Zeits. f. Physik*, 60. 5–6. *pp.* 345–363, 1930.

The molecular light scattering by solids (Raman effect) is treated by quantum mechanics, using Dirac's method. To a first approximation, the results agree with those obtained classically [see preceding Abstract], differing only in the relationship between temperature and intensity of the Stokes scattering. In this connection the quantum theory is preferable. A. C. M.

2552. Light Scattering in Crystals at High Temperatures. Part II. G. Landsberg and L. Mandelstam. *Zeits. f. Physik*, 60. 5–6. *pp.* 364–375, 1930.

The intensities of the modified lines due to scattering in quartz are measured between the temperature range 22° to 537° C. In Part I [see Abstract 459 (1929)] the intensities were observed between 20° and 210° C. As well as the marked intensity increase of the violet (anti-Stokes) lines with temperature, there is also an unmistakable increase in intensity of the Stokes lines. The intensity observations are in qualitative agreement with the theoretical requirements [see two preceding Abstracts], which are that for very high temperatures the Stokes and anti-Stokes lines are of equal intensity, and both increase approximately linearly with the temperature. For moderate temperatures are assumed $\mathrm{I}_r = \frac{\mathrm{A}}{1 - e^{-h\nu/kt}}$ and $\mathrm{I}_v = \frac{\mathrm{A}' e^{-h\nu/kt}}{1 - e^{-h\nu/kt}}$ for the intensities of the red and violet modified lines respectively. The ratio of intensities of the unmodified lines at 537° and at 22° C. respectively were all about 2·75, agreeing with the ratio of the absolute temperatures $\left(\frac{810}{295}\right)$. This showed that no unintended light was obtruding itself through stray reflections and the like. On the average, eight modified Stokes lines were 1·29 times as strong at 537° C. as at 22° C. The formulæ given above would lead one to expect a ratio 1·6 : 1. The discrepancy can probably be at least partly accounted for by the increasing broadness of the lines at higher temperature. A similar qualitative agreement was shown to hold for the change in the ratio $\frac{\mathrm{I}_v}{\mathrm{I}_r}$ in going from one temperature to the other. A. C. M.

2553. Method of Observing the Raman Effect in Liquids. J. Zahradniček and B. Vlach. *Zeits. f. Physik*, 60. 5–6. *pp*. 402–404, 1930.

Description of a simple method of observing the Raman effect in liquids. G. C. McV.

2554. Raman Effect in Water. P. Pringsheim and S. Schlivitch. *Zeits. f. Physik*, 60. 9–10. *pp*. 581–585, 1930.

When water is irradiated with light from a mercury-vapour lamp, three bands are observed in the visible region. These are to be attributed to the same Raman shift from the three different primary exciting lines at 3655, 4047 and 4358 Å., and not, as has been suggested recently by Meyer [see Abstract 2459 (1929)] and Gerlach (*Naturwissenschaften* 17. 68. 1930], to different Raman shifts from the same primary line. This was shown by the use of filters: nickel-oxide glass to cut out all but λ3655, and æsculine solution to cut out practically all but λ4358. In addition, the alleged relative change in intensity with temperature of the bands, and the alleged relative change in intensity when lithium chloride is dissolved in the water, are shown to be spurious. A. C. M.

2555. Raman Effect and Infra-Red Spectra of CCl_4 and $SiCl_4$. C. Schaefer. *Zeits. f. Physik*, 60. 9–10. *pp*. 586–594, 1930.

The molecules of CCl_4 and $SiCl_4$ are considered to be represented by a tetrahedral arrangement of Cl atoms, with the carbon (or silicon) atom at the centre of gravity. This is the same structure as is possessed by methane, so that the theoretical investigation of Dennison [see Abstract 307 (1926)] is used to give results for two molecules now under discussion. This results in the expectation of four fundamental frequencies: one inactive frequency ν_1, another inactive frequency (double) ν_2, an active frequency (treble) ν_3, and another active frequency (treble) ν_4. Thus, the degrees of freedom (9) are represented, but because of the symmetry of the

molecule only 4 frequencies result. In CCl_4 these frequencies correspond to wave-lengths $21{\cdot}83\,\mu$, $46{\cdot}07\,\mu$, $13{\cdot}21\,\mu$ and $12{\cdot}61\,\mu$, and $31{\cdot}74\,\mu$, in $SiCl_4$ to $23{\cdot}47\,\mu$, $65{\cdot}78\,\mu$, $16{\cdot}67\,\mu$ and $47{\cdot}62\,\mu$. The expected continuations are found for these two in the infra-red, based on these frequencies as fundamentals. Similar explanations are suggested for $TiCl_4$ and $SnCl_4$.
A. C. M.

2556. Connection between Intensity, Polarisation, and Scattering Angle for Raman Radiation. G. I. Pokrowski and E. A. Gordon. *Ann. d. Physik*, 4. 4. *pp.* 488–492, *Feb.* 24, 1930.

Assuming the scattering centres to scatter according to Rayleigh's Law $J = J_0(1 + \cos^2\theta)$, the net scattered radiation will obey the same law provided it is incoherent radiation. Coherence of the light will lead to inequality between the scattered intensities in directions making the same angle θ with the forward and backward directions respectively. Measurements on the Raman scattering from water and benzene showed such an inequality, $\frac{J_\theta}{J_{\pi-\theta}}$ being of the order $3{\cdot}0$, at $\theta = 20°$. It is concluded that the Raman radiation is partially coherent. Measurements of the polarisation of the Raman radiation are also included.
W. S. S.

2557. Anomalous Zeeman Effect. P. Drumaux. *Assoc. Ing. El. Liège, Bull.* 7. *pp.* 101–108, *Aug.-Sept.*; 142–156, *Oct.-Nov.*, *and pp.* 164–172, *Dec.*, 1929.

This paper, in three serial portions, gives a summary of the theory of the anomalous Zeeman effect. The first portion deals with the classical theory, the second with the classical quantum theory and the description of the effect in different multiplets, and the final portion gives the quantum-mechanics treatment, using wave mechanics and the matrix mechanics of Heisenberg and Dirac.
A. C. M.

2558. Theory of Zeeman Effect in Salts of Rare Earths. H. Bethe. *Zeits. f. Physik*, 60. 3–4. *pp.* 218–233, 1930.

The Zeeman effect in spectra of salts of the rare earths is treated by means of the author's quantum mechanics of atoms in crystals. The great separation of each line into a magnetic doublet, frequently accompanied by anomalous polarisation, is deduced, in agreement with J. Becquerel's experimental results [see Abstract 3331 (1929)], but without making any special assumption as to the separation factor.
G. E. A.

2559. Emission of Spectral Lines in an Electric Field. E. Sevin. *Comptes Rendus*, 190. *pp.* 296–298, *Feb.* 3, 1930.

A mathematical discussion explaining Stark's observation that when lines are observed along electric lines of force the intensity of the component deviated to the red differs from that of the component deviated to the violet.
F. S.

2560. Magnetophotophoresis and Electrophotophoresis. F. Ehrenhaft, M. Reiss and E. Wasser. *Zeits. f. Physik*, 60. 11–12. *pp.* 754–758, 1930.

Shows that the photophoresis of submicroscopic experimental bodies in or against the direction of the light rays is influenced by homogeneous magnetic or electric fields. Under the action of such fields in a direction perpendicular to the beam of light, a motion in or against the lines of force takes place. If it be assumed that the original temperature distribution on the bodies is altered by the electric or magnetic fields, then the photophoresis can be explained by means of radiometric forces produced by the temperature distribution on the experimental bodies. In this case, however, thermomagnetic effects on the one hand and electrothermic effects on the other hand can be used to explain the above new phenomena. [See also Abstract 2207 (1930).] R. C. F.

2561. Reflection of X-Rays of Long Wave-Length by a Plane Mirror. J. Thibaud. *J. de Physique et de Radium,* 1. *pp.* 37–48, *Feb.,* 1930.

The earlier work of the author on the measurement of the critical angle for the reflection of X-rays by glass gratings is reviewed. The problem of the reflection of X-rays by a plane mirror is studied theoretically, from which it is shown that the critical angle can be calculated from experimental curves showing the relation between intensity of reflection and the angle of reflection. This method is applied to the results of Dershem for the reflection of the carbon Kα line by a glass mirror. The calculated critical angle is 6° 12′, which corresponds with an index of refraction (δ) of $5{\cdot}84 \,.\, 10^{-3}$. This result agrees well with the value of $5{\cdot}73 \,.\, 10^{-3}$ calculated from the author's experiments on glass gratings, using the Kallman-Mark dispersion formula. F. J. W.

2562. Refractive Index of Various Substances for X-Rays. K. Kellermann. *Ann. d. Physik,* 4. 2. *pp.* 185–214, *Jan.* 28, 1930.

A method has been developed for the measurement of the refractive index of substances for X-rays, which is dependent upon the determination of the angle of total reflection. It has been applied to crown glass, silver, and also the liquids glycerin and an aqueous solution of calcium chloride. The results obtained are probably accurate to within ± 4 % for the solids and ± 7 % for the liquids. F. J. W.

2563. J-Phenomenon in X-Rays. N. S. Alexander. *Phys. Soc., Proc.* 42. *pp.* 82–95; *Disc.,* 95–96, *Feb.* 15, 1930.

A series of experiments have been carried out with the view of repeating as far as possible the work of Barkla and others on the J-phenomenon. The results obtained in no case provide any evidence for this phenomenon, and, considered in conjunction with the work of Dunbar, Worsnop and Gaertner, the experimental results suggest that the J-phenomenon has no real existence as an X-ray absorption effect.

AUTHOR.

2564. Statistical Fluctuations in Absorption by Quanta of X-Rays. H. J. Cohn-Peters and F. Lange. *Ann. d. Physik,* 4. 4. *pp.* 453–487, *Feb.* 24, 1930.

A sensitive differential method was used in which a beam of X-rays was passed in turn through two ionisation chambers, the circuit arrangements being such that the average ionisation currents through the two chambers balanced out, only the difference of the deviations from the average currents being recorded by the string electrometer. The method enabled an intensity difference of 0·001 % of the average to be detected. By repeated observations of the net charge accumulating on the electrometer in a period of 10 sec. it was established that true statistical fluctuations in the X-ray absorption occur, which obey the Gauss law and are of the right amount as given by theory. The fluctuation measurements can also be used to determine the energy necessary for the formation of an ion pair in the gas of the ionisation chamber. W. S. S.

2565. X-Ray Scattering Power of the Carbon Atom in Diamond. G. W. Brindley. *Phil. Mag.* 9. *pp.* 204–208, *Feb.*, 1930.

A theoretical F curve is calculated for carbon which, beyond $\sin\theta = 0\cdot 3$, depends almost entirely on the K electrons, for which the simple theory is adequate. There is satisfactory agreement between the calculated curve and the recent experimental data of Armstrong. W. H. Ge.

2566. Method of Activating Matter. G. Reboul. *Comptes Rendus*, 190. *pp.* 374–375, *Feb.* 10, 1930.

The activity produced in different metals behaves like induced radioactivity. With lead activated at 20,000 volts the constant $\lambda = 0\cdot 0003$ sec.$^{-1}$, and the mean life is 40 minutes. The coefficient of absorption of the radiation in aluminium varies from 200 cm.$^{-1}$ to 50 cm.$^{-1}$ when the thickness varies from 0·01 mm. to 0·1 mm.; this shows that the radiation is complex. The above constants do not vary much with the voltage of activation, or with the nature of the metal activated. It seems probable that electrified centres produced in the surrounding gas by the action of the cells serve as points of condensation for an emanation existing in the surrounding medium, and that this is deposited on the metal plates. The author's laboratory, however, has never been used for radioactive research. The effect obtained seems to be greater than can be expected from emanation in the atmosphere. [See also Abstract 2212 (1930).] H. N. A.

2567. New Weak Lines in the K-Series of Elements Vanadium to Yttrium. H. Beuthe. *Zeits. f. Physik*, 60. 9–10. *pp.* 603–616, 1930.

Two new lines have been discovered in the K series of the elements V to Yt, one of which for the elements Ni to V is of a wave-length shorter than the accompanying absorption edge. The wave-lengths of these lines are independent of the nature of the chemical compound in which the element occurs. These lines can be expressed as the sum or difference of two known lines. F. J. W.

2568. Influence of Chemical Combination on X-ray K-Emission Spectrum of Sulphur. O. Lundquist. *Zeits. f. Physik*, 60. 9–10. *pp.* 642–651, 1930.

Some fifty metallic sulphides and sulphates were investigated, as well as the free element. The β lines of the free sulphur consist of two powerful lines, β_1 and β_x, situated at 5020·9 and 5013·2. Considerable variation in the β lines of the sulphides occurs, some giving two lines, others one line only or a broad band. For the sulphates, with one exception (Cs_2SO_4), two β lines are obtained, the β_1 line agreeing in each case with that of the free element. The β_x line of about 14 of the sulphates also agrees with that of the free element, the β_x lines of the remaining sulphates (alkali and alkaline earth) having a common, slightly greater wave-length. The $\alpha_1\alpha_2$ doublet was found to be the same for the free element, and all the sulphides investigated. With the sulphates, however, as found by Backlin, three α lines are observed consisting of the doublet of free sulphur superimposed on the displaced doublet arising from the sulphur in the sulphate group, two of these four lines coinciding. W. S. S.

RADIOACTIVITY.

2569. Use of Radioactive Substances in Chemical and Physico-Chemical Research. O. Hahn. *Preuss. Akad. Wiss. Berlin, Ber.* 26. *pp.* 535–542, 1929.

Use may be made of both the "indicator" and the "emanation" methods for following chemical and physico-chemical processes. The former, in which the radioactive element serves as indicator owing to its adsorption on precipitates, makes use of elements which form readily detectable radioactive isotopes. In the emanation method, use is always made of the noble gas emanation of known physical properties, the behaviour of substances in which it is spontaneously developed being investigated with its help. The emanation power of a substance represents the proportion of the total emanation which diffuses out from the substance. High emanation power indicates large internal surface, and hence spongy structure, whereas coarsely crystalline substances, with which the external geometrical surface differs little from the total active surface, have low emanation powers. Various examples of the application of these methods are given. T. H. P.

2570. Heat Emission of Radioactive Minerals. (Miss) A. Dorabialska. *Acad. Polonaise Sci. et Lettres, Bull.* 1–2*a*. *pp.* 42–49, *Jan.–Feb.*, 1930. *In French.*

By the method previously used [see Abstract 1496 (1930)] the following heat emissions (in gm.cal./hr. × 10^5) have been determined: uraninite (Norway) 5·7; johannite (Ehrenfriedersdorf) 3·3; thorianite (Ceylon) 7·5; orangite (Arendal) 72·0; orangite (Langesund) 360·0; thorite (Norway) 180·0; monazite (massive, Norway) 36·0. The results for the three first are normal, save that for johannite is somewhat low, which is probably due to its being a secondary mineral. The figures for orangite, confirming Poole's results [see Abstract 690 (1912)], thorite and monazite are far in excess of those corresponding to their known constituents, and point to the presence of some unknown source of heat. C. A. S.

2571. Radioactivity of Various Metals from Old Roofing. A. Boutaric and Madeleine Roy. *Comptes Rendus*, 190. *pp.* 483–485, *Feb.* 24, 1930.

Four samples of lead, two of zinc and one of copper sheeting that had been on roofs for from 20 to 95 years were examined. Plates of each were used in place of the aluminium base plate of a Szilard electrometer, and the rate of discharge noted. With the side of the metal that had not been exposed to the air uppermost the rate of discharge was practically the same as with the original aluminium (0·3 to 1·5 in arbitrary units). But with the exposed side uppermost the rate was from 3 to 7. Further, if that side were scraped slightly, all radioactive effect was found in the scrapings. Various explanations are considered, and the most probable cause thought to be fixation of radioactive material from the atmosphere. C. A. S.

2572. Radioactive Decay. F. Běhounek. *Phys. Zeits.* 31. *pp.* 215–224, *March* 1, 1930.

The experiments of Mlle. St. Maracineanu on the influence of solar radiation on radioactivity were repeated with UO_3 and U_3O_8 and with Pb, Cu and Zn, but no influence of the insolation on the activity of the uranium oxide was found, nor was any activation of the exposed metals noticed. Three polonium preparations were exposed, one at a depth of 813 m. below sea-level in a lead mine, one at 200 m., and one at 1332 m. above sea-level, but no change of the decay constant could be established, although according to Bogojavlensky this would be expected on account of the different geological formations of the three places. An investigation with the β-radiating UX_1, in which a change of 0·7 % in its decay constant could have been detected, gave also a negative result. J. J. S.

2573. Measurements of the Products of Atomic Disintegration from Al, Be, Fe and C by Retrograde Method. H. Pose. *Zeits. f. Physik*, 60. 3–4. *pp.* 156–167, 1930.

The experiments were carried out with α-particles from polonium, the method being the same as that employed previously by Hoffmann and Pose. Special pains were taken in investigating the ionisation produced in the interior of the apparatus, in the absence of the polonium preparation, owing to unavoidable radioactive contamination. This was carefully kept as low as possible. The results show that Al, Be and Fe give a small number of H-particles with an angle of 135° between the primary and secondary rays, the order of magnitude being 5×10^{-8} H-particles per α-particle. No positive effect was obtained with carbon. The above figure is small compared with more or less corresponding figures obtained by other observers, but seem to support the Cambridge measurements and those of Bothe and Franz as opposed to the Vienna measurements.

H. N .A.

2574. Wave-Mechanics Basis for the Nernst Hypothesis of the Regeneration of Radioactive Elements. J. Kudar. *Zeits. f. Physik*, 60. 5–6. *pp.* 292–297, 1930.

The author discusses the wave-mechanics theory of the interaction between a nucleus and an α-particle when the energy of the α-particle is in the neighbourhood of an eigen energy of the nucleus. It is shown that an α-particle impinging on to a nucleus with a velocity corresponding to an unoccupied energy level of the nucleus will be absorbed by the nucleus without resistance, *i.e.*, there will be no reflection at the potential wall forming the surface of the nucleus. Radioactive disintegration and regeneration are thus reversible processes in accordance with the Nernst hypothesis. [See also Abstract 1896 (1929).] W. S. S.

2575. α-Rays of Abnormally Great Range from ThC. E. Stahel. *Zeits. f. Physik*, 60. 9–10. *pp.* 595–598, 1930.

It is shown that the α-rays of range beyond the normal are certainly not sent out from ThC″, but must come either from ThC or from ThC′. A pure preparation of ThC″ was examined. For the 11·5 cm. α-rays visual observations were made with the Wilson apparatus. For the second group of α-rays of 9·5 cm. range photographic registration was employed. The results indicated that ThC″ sent out neither of these groups of α-rays, so that their source must be either from ThC or ThC′. J. J. S.

2576. Quantum Mechanics of α-Radiation. T. Sexl. *Zeits. f. Physik*, 59. 9–10. *pp.* 579–582, 1930.

The author opposes the criticism of Atkinson and Houtermans [see Abstract 1093 (1930)], in which they consider that the choice of the potential as null in the interior of the nucleus vitiates his calculation of the radioactive disintegration constants [see Abstract 225 (1930)]. This assumption, which physically interpreted means that the particle in the interior of the nucleus is considered as "free," he regards as the simplest. J. J. S.

2577. Scattering of α-Particles by Light Atoms. A. C. Banerji. *Phil. Mag.* 9. *pp.* 273–292, *Feb.*, 1930.

A mathematical discussion of the scattering of α-particles by light atoms. The scattering by Al and Mg is specially treated. J. J. S.

2578. Model to Illustrate the Path of an α-Particle Near an Atomic Nucleus. E. N. da C. Andrade. *Journ. Sci. Instruments*, 7. *pp.* 94–96, *March*, 1930.

The model consists of a smooth hard surface (originally brass) which is symmetrical about the vertical axis through its centre. The surface rises up sharply towards the centre, and is nearly horizontal at the edges. A small sphere allowed to roll down an adjustable run-way on to the surface is apparently repelled from the centre owing to the rise of the surface. The contour of the surface is so adjusted that the path of the small sphere is hyperbolic, representing, therefore, the track of an α-particle scattered by an atomic nucleus. A later model in glass permits of the projection of the experiment on to the screen. W. S. S.

2579. Capture of Electrons by α-Particles. A. H. Barnes. *Phys. Rev.* 35. *pp.* 217–228, *Feb.* 1, 1930.

A stream of electrons is superposed upon a beam of α-particles, which are then deflected by a magnetic field and counted by the scintillation method. Electrons are captured when their velocity equals that of the α-particles, and also at a series of discrete velocities both greater and less than that of the α-particle. Both single and double capture occur at zero relative velocity. After certain calculations the conclusion is reached that for capture to occur the electron must, due to some external field, possess a kinetic energy which, with respect to the nucleus, is either zero or equal to the energy of one of the quantum states of the atom. The time required for capture of the electron by the α-particles is given. The experiments are described, and among the conclusions is the discovery that electron capture is governed by a definite energy condition [See also Abstract 229 (1930).] T. C. H.

2580. Absolute Determination of Energy of Primary β-Rays from Radium E. (Miss) L. Meitner and W. Orthmann. *Zeits. f. Physik*, 60. 3–4. *pp.* 143–155, 1930.

The method employed was a calorimetric one, and the mean value of the energy of a primary β-particle was determined. The number of radium E atoms disintegrating per sec. was arrived at by preparing standard preparations, calibrated in radium equivalents. The most probable value as obtained is 337,000 volts ± 6 %, which agrees well with the value 344,000 volts ± 10 % obtained by Ellis and Wooster. The actual velocities of the β-particles vary from about one million down to 200,000 volts, and a continuous magnetic spectrum is obtained. This distribution of velocity and energy exists when the β-particles leave the atomic nuclei. A special experiment showed that RaE does not emit a continuous γ-ray spectrum, which might compensate for the inhomogeneous character of the disintegration energy given out in the form of β-radiation. From the experi-

ments it can be deduced that the number of atoms disintegrating in a second in a gramme of radium is $3 \cdot 68.10^{10}$, with a maximum error of 5 %.
H. N. A.

2581. Nature of β-Disintegration According to Wave Mechanics. Parts II and III. J. Kudar. *Zeits. f. Physik,* 60. 3–4. *pp.* 168–180, 1930.

In Gamow's theory of α-disintegration it is assumed that the azimuthal quantum number of the α-particle is zero. This agrees with the fact that α-particles are subject to the Bose statistics; all α-particles in the α-conglomerate of the nucleus are in the same quantum state. For electrons, on the other hand, Fermi statistics hold, the two spin possibilities must be considered, and the different electrons will have different quantum numbers. It is shown that it is impossible for the azimuthal quantum numbers of the electrons to be zero as is the case with the α-particles, and the author concludes that, for an electron which can be ejected from the nucleus in disintegration, it is possible to obtain the correct order of magnitude for the β-disintegration constant by assuming $n = 4$. The union of the β-electron with positive energy comes about by the neutralisation of the outward acting centrifugal force by an attraction of some kind in the interior of the nucleus. An explanation is found for the continuity of the primary β-spectra. No γ-radiation is required to accompany the β-radiation according to this theory, and this agrees with the latest experimental results. [See also Abstract 672 (1930) and following Abstract.]
H. N. A.

2582. Nature of β-Disintegration According to Wave Mechanics. Part IV. J. Kudar. *Zeits. f. Physik,* 60. 9–10. *pp.* 686–689, 1930.

The interpretation of the formula for the β-disintegration constants arrived at in Part III is here modified as follows; the constants are not determined by the somewhat indefinite lower limit of the primary β-spectrum, but by the most probable disintegration energy. This also gives a breadth of the primary β-spectrum which is in good agreement with the observations. The result deduced, that the spin and orbital impulse of the nuclear electrons are in the same direction, is discussed. [See also preceding Abstract.]
H. N. A.

2583. Experiments with Electron Counter. A. K. Das and K. Wölcken. *Phys. Zeits.* 31. *pp.* 136–139, *Feb.* 1, 1930.

The electron counter was similar to that of Geiger and Müller [see Abstract 1237 (1929)]. The γ-radiation from radium was examined, and found to give 123 impulses per min. per sq. cm. of surface; this agrees with the figure found by Neufeldt, but is higher than that of Geiger and Müller. The mass absorption coefficient for radium γ-rays was determined and the inverse square law verified for the intensity of the radiation. J. H. A.

HEAT.

2584. Measurement of Heat Conductivity of Atmospheric Nitrogen up to 500°C. T. Wilner and G. Borelius. *Ann. d. Physik,* 4. 3. *pp.* 316–322, *Feb.* 8, 1930.

The measurements were made by the cylinder method of Schliermacher. The inner electrically-heated cylinder was of pure platinum of diameter 3·05 mm., and wall thickness 0·5 mm. The outer cylinder was of rustless steel, and of diameter 23·00 mm. The platinum tube also served as a resistance thermometer. The tubes were placed in an electric furnace. Details of the apparatus with a diagram are given. The measurements are, so far as the authors are aware, the first absolute measurements to be made on a gas above 200° C. The values of the conductivities of gases at high temperatures which are often required have been obtained indirectly from the formula $\lambda = kc_v\eta$, where η is the internal friction and c_v the specific heat. The results so obtained are somewhat uncertain on account of the value of k for polyatomic gases, and hence direct experimental values are desirable, and these have been obtained by the authors. The values obtained for k were: at 325° C. $1{\cdot}84 \pm 0{\cdot}10$, and at 500° C. $1{\cdot}85 \pm 0{\cdot}06$.

T. B.

2585. Problems in Heat Conduction. G. Green. *Phil. Mag.* 9. *pp.* 241–260, *Feb.*, 1930.

Previous papers by the same author have developed a method of solution of problems on heat conduction by means of wave-trains, the fundamental solutions of the problems being developed to form the basis for solution of particular cases. The method is useful in all cases of plane, spherical or cylindrical heat distribution, and has the advantage that direct application of the general physical ideas of transmission of a wave-train across a boundary, or together with its reflection from a boundary, yield the mathematical solutions desired. The normal coordinates, usually obtained by a separate investigation, are derived in the natural course of applying this method, their particular form for each special case becoming evident when the boundary conditions are applied to each constituent wave-train of a given frequency. The present paper demonstrates the suitability of the method, and indicates its scope in the treatment of problems of heat conduction of considerable interest and difficulty. The paper is mathematical throughout, and deals with, amongst others, the cases of: (1) Determination of the temperature in a finite rod of length (a) having an initial temperature distribution given by $f(x)$ and under a condition at the boundaries $x = 0$ and $x = a$, which may be that radiation takes place there to a medium at zero temperature, or that the temperature there is maintained at zero, or any similar condition. (2) Determination of the temperature at any point within a sphere of radius (a) having an initial temperature distribution represented by $v = f(r)$ and subject to a boundary condition at surface $r = a$, which is specified. (3) Treatment of the case of a sphere of one material bounded by a concentric spherical surface, the whole having an initial temperature distribution $f(r)$ and, as before in (2), subject to any specified condition at the outer boundary of the outer material. The problem of the determination of the temperature at any point in the case where radiation occurs at the outer boundary of the outer material is solved in the paper as far as the essential form of the solution is concerned, the detailed treatment being reserved for later work. Similarly, the question of heat conduction in an inner sphere enclosed in a different material extending to infinity can be treated by this method, and its solution would be of interest. S. G. B.

2586. Distribution of Heat above a Heated Plate Placed in a Current of Air. F. Éliás. Part I. Scope and Results of Experimental Work. Part II. Theory of the Method. *Zeits. f. angew. Math. u. Mechanik. Part I.* 9. *pp.* 434–453, *Dec.*, 1929, *and Part II.* 10. *pp.* 1–14, *Jan.–Feb.*, 1930.

The work described is an attempt to measure and determine the temperature and stream-line field above a heated plane plate which is placed in an air current the direction of which is parallel to the surface of the plate. The friction and heat dissipation along the plate are ascertained, and the experimental results compared with mathematical theory. Full details are given, together with profuse diagrams. S. G. B.

2587. Brownian Movements in a Field of Thermal Radiation. T. Takéuchi. *Comptes Rendus,* 190. *pp.* 292–293, *Feb.* 3, 1930.

Considers an enclosure traversed by dark radiations with the temperature T, and containing material particles. The particles will have Brownian motions due to fluctuations in the radiations absorbed, emitted and reflected, and these are studied according to the theory of photons. A particle placed in the isothermal radiation experiences a viscous resistance when it moves, $f = -\lambda v$, f is the radiation viscosity. It is shown that if k is Boltzmann's constant, m the mass of a spherical particle which completely absorbs all the radiations, X^2 the mean square of the impulses in the X direction during time τ, $\bar{\xi}^2$ the mean square of the displacement of the particle in the X direction during τ, and $\bar{v}^2$ the mean square velocity, then $m\bar{v}^2 = k\mathrm{T}$, $\bar{\xi}^2/2\tau = k\mathrm{T}/\lambda$, $\sqrt{\bar{X}^2} = \sqrt{\bar{\xi}^2}\lambda$. For a particle which reflects the radiations of all frequencies completely the same result will be obtained. *Errata, ibid.* p. 456, Feb. 17, 1930. H. N. A.

2588. Undulatory Theory and Black Radiation. L. Décombe. *Comptes Rendus,* 190. *pp.* 479–481, *Feb.* 24, 1930.

Planck's formula for black radiation of frequency ν at temperature T, $h\nu/(e^{h\nu/k\mathrm{T}} - 1)$, is deduced from the theory of the electron and proton as pulsating spherical pellicles, the frequency of the pulsations of which is proportional to the electrostatic energy, and consequently to the mass. In this way any assumption of the discontinuity of energy is avoided. [See also Abstracts 2364 (1929) and 919 (1930).] C. A. S.

2589. Black Bodies in the Extreme Infra-Red. C. H. Cartwright. *Phys. Rev.* 35. *pp.* 415–420, *Feb.* 15, 1930.

For blackening a receiver of a thermocouple for radiation for obtaining pure rotation band spectra, it is desirable to use a material that is an efficient absorber of the extreme infra-red but a poor absorber of radiation of shorter wave-lengths. The absorbing powers of 25 materials were tested for radiation of wave-lengths near 4 μ and greater than 50 μ. Of all the materials tested, white lead, litharge, red phosphorus, powdered glass, copper sulphide and celestite were found the best for covering a receiver to absorb the extreme infra-red radiation. The 25 materials were tested by painting them on a receiver of a thermocouple which was exposed to extreme infra-red radiation. The same receiver and thermocouple were used throughout the experiment. A D'Arsonval-type galvanometer was improved by using a quartz suspension and replacing each conducting lead with silver leaf or gold-plated silver ribbon 1 μ thick wound in a spiral. Hot glass made a good source of extreme infra-red radiation when used with a cold, thin glass shutter. AUTHOR.

2590. Radiometer Forces and Gas Exhaustion. T. Brings. *Zeits. f. Physik*, 60. 11–12. *pp.* 759–775, 1930.

Examines the dependence of the radiometer effect upon the external thermal conductivity of the uncoated vane material, and tests the conclusions of Sterntal's theory. The conductivity is varied by corrosion. When the unilluminated side of the vanes has a greater conductivity than the illuminated side, the deviation of the radiometer action from the action when the conductivities on both sides are equal increases with decreasing pressure, as predicted by Sterntal's theory. In the opposite case, the deviation is always greater at greater pressures, and reaches a maximum at 10^{-2} mm. of Hg. To explain this fact, certain additional assumptions have to be made concerning the effect of gas layers on the radiometer vanes. E. E. F. d'A.

2591. Twentieth Annual Exhibition of the Physical and Optical Societies. *Journ. Sci. Instruments*, 7. *pp.* 63–64, *Feb.*, 1930.

Notes on Exhibits: "Temperature Measuring Equipment," by **A. Ferguson.**

2592. Differential Calorimeter for Absolute Measurements of the Smallest Quantities of Heat. W. Orthmann. *Zeits. f. Physik.* 60. 3–4. *pp.* 137–142, 1930.

The apparatus described is capable of measurement of heat evolution as small as 5×10^{-3} cal. per hour with an experimental error of less than 4 %. The error is smaller for comparative measurements. The calorimeter was devised in extension of work carried out by Nernst and the author, and later with Meitner was used for the determination of the energy of the primary β-rays from RaE. Full experimental and constructional details are given in the text as well as excellent notes on technique. S. G. B.

2593. Apparatus for Determining the Specific Heat of a Material in Powder Form. J. H. Awbery and E. Griffiths. *Phys. Soc., Proc.* 42. *pp.* 71–73; *Disc.*, 73–74, *Feb.* 15, 1930.

A calorimeter suitable for heavy powdered materials, such as dry clay, is described. It utilises the electrical method, and embodies a special form of stirrer suitable for these materials. AUTHORS.

2594. Metal Vacuum Flask for Liquid Hydrogen. W. Meissner and B. Voigt. *Zeits. f. Instrumentenk.* 50. *pp.* 121–141, *Feb.*, 1930.

Describes a metal vacuum flask of 10 litres capacity, of a greatly improved pattern. The basis of the design is set out in great detail, and the original paper should be consulted. J. H. A.

2595. Errors Due to Capillarity in Mercury Thermometer Readings. C. E. Guillaume. *Archives des Sciences*, 12. *pp.* 5–10, *Jan.–Feb.*, 1930.

The mercurial meniscus does not always keep the same form, being convex when the temperature rises and concave when it falls, and a proof of this fact is given. The capillary error of a thermometer results in a compromise between the conditions, the use and the observation of the instrument. It is in the measure of the coefficient of pressure that this error appears most clearly. The experiment by which this is obtained is described. A curve shows the determination of the coefficient of pressure by the method of variable steps in the temperature, and the results are given in a table. The coefficient obtained by this means should still have a slight correction, due to the fact that at the same time as the change in the exterior pressure the variation of the height of the column of the thermometer modifies slightly the interior pressure. T. C. H.

2596. Calculation of Temperature of Flames and Influence of Atomic Hydrogen thereon. G. Ribaud. *Comptes Rendus*, 190. *pp*. 369–371, *Feb*. 10, 1930.

Values obtained by calculating for the temperature of flames given by mixtures of hydrogen, carbon and oxygen are notably higher than those given by direct measurement, even if account is taken of the dissociation of CO_2 and H_2O in the flame. For example, the value 4030° C. was calculated by Pollitzer for the flame $C_2H_2 + 2O$, while direct measurement gave 3100° C. The author has obtained figures much nearer the experimental results by taking into account the dissociation of H_2 into atomic hydrogen. The fractions of dissociation accepted in the calculations are those given by Langmuir, and for the heat of dissociation of the H_2 molecule the mean value 100,000 is taken. Equations are obtained by thermodynamic calculation, and from these equations the following results are given: Flame $H_2 + O$, $t = 2850°$ C. (3050° neglecting dissociation of H_2); Flame $C_2H_2 + 5O$, $t = 3200°$ C. (3780°); Flame $C_2H_2 + 2O$, $t = 2975°$ C. (3875°). T. B.

2597. Heat Capacities in Aqueous Solutions. F. D. Rossini. *Bureau of Standards, J. of Research*, 4. *pp*. 313–327, *Feb*., 1930.

The problem of properly evaluating the heat capacities of the constituents of aqueous solutions is discussed, and the methods of calculating from specific heat data possessing the necessary qualifications, the apparent molal heat capacity of the solute, the partial molal heat capacity of the solute, and the partial molal heat capacity of the H_2O are given. These partial molal quantities, evaluated from the specific heat data of Richards, and others, on aqueous solutions of hydrochloric acid, sodium hydroxide, acetic acid, sodium acetate, calcium chloride, barium chloride, citric acid, monosodium dihydrogen citrate, disodium monohydrogen citrate, and sodium citrate are given in tabular and graphic form. The importance of the results in interpreting the behaviour of ions and molecules in aqueous solution and their relation to the Debye-Hückel theory of strong electrolytes are discussed, AUTHOR.

2598. Standard Materials for Determination of Expansion of Solids. W. M. Cohn. *Ann. d. Physik*. 4. 4. *pp*. 493–512, *Feb*. 24, 1930.

The author briefly reviews the literature on materials so far used for expansion tests at high temperatures, and describes new experiments. His materials are: fused silica, distinguished as quartz glass (from crystallised quartz, transparent) and quartz ware (from sand, not free from bubbles). Both expanded regularly up to 1000° C., the latter less than the former. Above 1050° softening began with increased expansion, followed above 1100° by contraction. The curves were similar to those of good glasses. Zirconia, baked up 1800°, expanded almost linearly (with a slight bend near 240°) up to 1100°, but contracted then and behaved irregularly; the cooling curve from 1300° down was quite different from the heating curve which it crossed near 600°. Thus, zirconia would not be suitable above 1000°, but certain additions seem to improve it. A new stoneware made by the Deutsche Ton-und Steinzeugwerke of Charlottenburg, baked at 1400°, gave an almost linear curve, and is recommended up to 1200°. Marquardt mass (Berlin porcelain), also baked at 1400°, expanded slightly more, but is recommended up to 1400°, the heating and cooling curves being identical. Reference is made specially to the investigations of the Reichsanstalt and of the Bureau of Standards. [See Souder and Hidnert, Abstract 2890 (1926).] H. B.

2599. New Measurements on the Vapour-Pressure Curve of Liquid Helium. Part II. W. H. Keesom, S. Weber and G. Schmidt. *K. Akad. Amsterdam, Proc.* 32. 10. *pp.* 1314–1323, 1929. *Comm. No.* 202*c from the Phys. Lab., Leiden.*

In continuation of these measurements [see Abstract 1933 (1930)], results down to about 0·005 cm. of mercury are given. In this range the thermomolecular pressure difference attains to considerable importance, particularly in the helium thermometers, in which the pressure becomes very small. No extensive research on the thermomolecular pressure difference has been carried out, but data are available which determine the behaviour of this pressure difference with sufficient certainty for the purpose. The results of the new measurements of the vapour pressure of liquid helium may be expressed by the formulæ: for T above 2·19° K., $\log_{10} p(\text{cm.}) = -3{\cdot}024/T + 2{\cdot}208\log_{10}T + 1{\cdot}217$; for T below 2·19° K., $\log_{10} p(\text{cm.}) = -3{\cdot}859/T + 0{\cdot}922\log_{10}T + 2{\cdot}035$. T. H. P.

2600. Equations of State at Surfaces. N. Barbulescu. *Phys. Zeits.* 31. *pp.* 48–56, *Jan.* 1, 1930.

It is sought to establish the existence of a surface tension at the surfaces of gases and saturated vapours as well as of liquids. On the basis of the conditions set forth by Kelvin and Laplace the size of the surface tension of saturated vapours is calculated. It was found that the surface tension increases towards a maximum with increase of temperature, which was in the neighbourhood of the critical point. The relative surface tension between a liquid in contact with its vapour is equal to the difference between the individual surface tensions of liquid and vapour (saturated). The individual surface tension is defined as that of the liquid or saturated vapour individually in contact with air as the comparative medium. The Kelvin phenomenon of "perpetual motion" is explained. The Eötvös formula is criticised, and the discrepancy between theory and experiment is elucidated. The meaning of the factor "d" in the usual Eötvös formula is defined by the assumption that at the surface of the liquid two surface tensions exist, an inner and an outer. This assumption led to the establishment of a new equation of state at the surface, the validity of which is proved and the accuracy of the Eötvös formula demonstrated, for normal materials. The same formula can be used for abnormal media, by the assumption of Δ as a linear function of the temperature. The expression deduced is given below:

$$a_r V^{2/3} = K \,.\, \tau \,.\, e^{-\Delta/\tau}.$$

S. G. B.

2601. Derivation of Equation of State of a Mixture from the Equations of State of the Constituents. R. D. Kleeman. *Frank. Inst., J.* 209. *pp.* 229–236, *Feb.*, 1930.

An extension of a previous paper by the same author [see Abstract 554 (1929)]. The present work deals more specifically with the statement that the functions of the absolute temperature which the equations contain should be looked upon as entirely independent of each other. The investigation, outlined mathematically, furnishes the fundamental theory of the deduction of the equation of state of a mixture from the equations of state of the constituents. These may be summarised as: (1) When the masses of a mixture of substances are zero the pressure is zero. (2) The pressure is independent of the total mass. (3) When the masses of some of the constituents are zero the functional forms of ϕ and ψ and of Φ in the expressions deduced are not changed, thus leading to the corollary that when all the masses of the constituents are zero except one the equation becomes the equation of state of the latter constituent in the pure state. (4) The temperature functions involved are also not changed under these conditions. A general equation of state is given from which it is again possible to determine the physical and chemical properties of a mixture of substances, or of a compound, by means of the equations of state of the constituents. S. G. B.

2602. Thermodynamic Properties of Ammonia. Joule-Thomson Effect and Heat Capacity at Constant Pressure. J. A. Beattie. *J. Math. Phys., Mass. Inst. of Technology,* 9. *pp.* 11–21, *Feb.*, 1930.

Comparison of the values of the Joule-Thomson coefficient and of the pressure variation of the heat capacity at constant pressure calculated for ammonia from the Beattie-Bridgeman equation of state with those determined experimentally reveals satisfactory agreement for the Joule-Thomson data at temperatures above 30° C. and for the heat capacity at temperatures above 100° C. The greater divergences at lower temperatures are explainable partly by inconsistency between the compressibility and thermal data and partly by failure of the equation in question to represent all the trends in the compressibility data in the region close to the saturation line. Such comparison forms a severe test for an equation of state, owing to the large deviations from the ideal state exhibited by ammonia, and to the fact that most of the thermal data involved are for temperatures below the critical temperature. T. H. P.

2603. Principle of Inaccessibility of the Absolute Zero. N. A. Kolossowsky. *Phil. Mag.* 9. *pp.* 208–210, *Feb.*, 1930.

Points out that the principle was first clearly stated by Clausius, not by Nernst, as is commonly supposed. W. H. GE.

2604. Variation of Rotational Energy of Polyatomic Gases. K. Széll. *Zeits. f. Physik,* 60. 3–4. *pp.* 210–217, 1930.

The variation of rotational energy of polyatomic gases at high temperatures is first calculated from the Boltzmann-Gibbs equation. Then the variation in the single molecule is determined from the distribution function of the molecules by means of the possible energy values according to the quantum theory. The equations derived by the two methods are identical. G. E. A.

SOUND.

2605. Cavitation in the Track of an Ultrasonic Beam. R. W. Boyle, G. B. Taylor and D. K. Froman. *Roy. Soc. Canada, Trans.* 23. *Sect.* 3, *pp.* 187–198; *Disc.*, 199–201, *May*, 1929.

Boyle and Lehmann have found previously that in volatile organic liquids cavitation bubbles could be produced by an ultrasonic quartz generator, at lower energy densities than in water or in oil. They used the bubbles to indicate the position of ultrasonic stationary waves formed in benzol, toluol, xylol and other liquids. The bubbles are driven to or formed at nodal regions of stationary waves set up by reflecting the beam from a reflector, and curtains of bubbles parallel to the reflector may be made to rise through the liquid, at distances of half a wave-length apart, providing a means of determining the velocity of sound in the liquid column. In the present paper the authors have examined chemically the nature of these cavitation bubbles and the energy intensities required to produce them. It has been found that a large proportion of the gas is air, *e.g.*, 89 % of the gas collected from naphtha was air, the remaining 11 % being organic vapour. A torsion-wave pendulum was used to measure the intensity of the ultrasonic radiation. The power required to produce cavitation in naphtha was found to be 32 milliwatts/cm^2. A. B. W.

2606. Rotation of Small Plates in a Sounding Air Column. A. Schmidt. *Zeits. f. Physik*, 60. 3. 4. *pp.* 196–209, 1930.

In the final arrangement described, the air inside a long tube closed at one end is set into vibration by means of a telephone diaphragm maintained by a three-valve oscillating circuit. The plate consisted of a slice of paraffin wax held inside a brass ring and pivoted inside the tube with its axis perpendicular to the air current. At the nodes of the stationary waves rotation begins of itself, but at antinodes it has to be started by external means. [See also Abstract 1214 (1926).] G. E. A.

2607. Effect of Reverberation Time in the Reproduction of Sounds. E. A. Johnson. *J. Math. Phys., Mass. Inst. of Technology*, 9. *pp.* 1–10, *Feb.*, 1930.

The purpose of the paper is to determine, from a consideration of the acoustical constants of the room in which the sounds originate and of that in which it is reproduced, the apparent reverberation time (T) in the latter. The time of reverberation is that taken by the sounds to reach 10^{-6} of their original intensity. Expressions are found for T in terms of T_1 and T_2, the reverberation times for the two rooms, and it is concluded that, by using the analysis given, it will be possible to design studios and recording-rooms to meet any conditions of reproduction. G. E. A.

2608. Dynamical Theory of Resonators. E. T. Hanson. *Phys. Soc., Proc.* 42. *pp.* 43–54; *Disc.*, 55–57, *Feb.* 15, 1930.

It is well known that the theory of the small resonator provided with a neck communicating with the open air depends upon the assumption that the air within the neck may be treated as an incompressible fluid. In the present paper the theory is extended to include generally necks of variable cross-section. Rayleigh developed three theories depending upon the assumptions made as to the velocity-distribution of the air at the open end of a resonator. It is shown that his theory, which assumes a variable velocity-distribution over the open end, is erroneous, and a theory which appears to be correct is put forward. The theory of the neck of variable cross-section is applied to the Helmholtz resonator, and the theory of an open end of rectangular cross-section is considered. The general theory of resonators is dealt with. It is shown that impedance principles require modification for certain types, although they hold for most of the common types. AUTHOR.

2609. Resonator Theory. K. Schuster. *Ann. d. Physik*, 4. 4. *pp*. 513–532, *Feb*. 24, 1930.

A theoretical treatment of the vibration in an enclosed space divided into two parts by openings of various size. W. H. GE.

2610. "Annular Effect" in Resonators observed by E. G. Richardson. T. Sexl. *Zeits. f. Physik*, 61. 5–6. *pp*. 349–362, 1930.

The effect observed by Richardson that in resonators the amplitude of the vibrations is a maximum near the wall of the resonator is shortly recapitulated. It is shown that the results found can be derived, qualitatively and quantitatively, from the hydrodynamical equations of Stokes and Navier. [See Abstract 2784 (1928).] G. E. A.

2611. Struck String Theory. K. C. Kar and M. Ghosh. *Phil. Mag*. 9. *pp*. 306–324, *Feb*., 1930. *Zeits. f. Physik*, 61. 7–8. *pp*. 525–537, 1930.

A further discussion of the string struck by an unyielding hammer when the effect of damping is neglected. During the impact the combination of hammer and string is treated as a loaded string as in the Raman-Banerji theory, but with the necessary corrections, and it is claimed that the intermittent action treatment as used in quantum physics is more elegant than the method of variation of integration constant used by Kaufmann, Love and Das. The papers are purely theoretical. W. H. GE.

2612. Calibration of a Tuning Fork by Comparison with a Pendulum. C. Moon. *Bureau of Standards, J. of Research*, 4. *pp*. 213–219, *Feb*., 1930.

A photographic method for determining the relative frequency of a tuning fork and pendulum is described in which no energy is drawn either from the fork, the pendulum, or from the fork-driving circuits. A photographic record is obtained from which the frequency of the fork, the amplitude of the fork, and the amplitude of the pendulum are obtained. The accuracy of the timing is such that the time interval for an integral number of fork vibrations can be determined to 20 microseconds. If the pendulum is timed over an interval of 1 sec., the error in frequency will be $\pm 0\cdot002\ \%$. If the time interval is increased to n seconds, the error will be $\pm \frac{1}{n} \times 0\cdot002\ \%$. Irregularities in relative frequency have been found which are thought to be due to a variable rate of the pendulum caused by microseismic movements of the building. Curves are given showing the frequency amplitude relation for two forks (one of steel and one of elinvar) when vibrating freely. AUTHOR.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

2613. Polysymmetric Static Machines of the Toepler-Holtz Type. A. W. Simon. *Rev. Sci. Instruments,* 1. *pp.* 57–64, *Feb.,* 1930.

It is pointed out that the ordinary Toepler-Holtz static machine is the two-symmetric member of a whole family of polysymmetric static machines of the same general type, in which the number of symmetries (or inductors) can be both even and odd. Historically only the even-symmetric members were built on account of the fact that the significance of the angle which the neutralising rods make with each other was not understood. In the generalised machine the angle made by the neutralising rods is 2π divided by the number of symmetries. The detailed theory of the four and the five symmetric members is developed and then generalised to higher members. It is shown that machines with an even number of symmetries are essentially direct-current machines, while those with an odd number are alternators. It is shown also that the even-numbered machines can also alternate if properly excited; however, that they are most efficient (as regards potential transformation) when acting as direct-current machines. It is also shown that the efficiency (of potential transformation) increases with the number of symmetries, so that multiple-inductor machines should be more powerful than the two-inductor machines. Formulæ for the period of alternation and the factor of potential transformation per revolution are deduced. AUTHOR.

2614. Oscillations of Mercury Drops Produced by the Johnsen-Rahbek Effect. M. Katalinić. *Zeits. f. Physik,* 60. 11–12. *pp.* 795–824, 1930.

Under the action of the Johnsen-Rahbek effect, mercury drops when subjected to an alternating voltage are set in oscillation, and in large drops stationary waves are produced. The oscillation curve for small drops has now been investigated, and the mode of occurrence of large-drop oscillation determined, the reciprocal connection between the components of the latter phenomenon being explained. Measurements of the oscillation duration and the relative phase displacement of the oscillations, as well as the dependence of the amplitude and wave-length on the drop magnitude and on the effective value of the imposed alternating voltage, are given. Finally, the amplitude at the swelling-point is calculated. The amplitudes increase, within the voltage range investigated, proportionally with the square of the effective value of the imposed alternating voltage, as do the limiting values of the electrostatic attractive force. *Erratum, ibid.* 62. 7–8. p. 584, 1930. H. H. Ho.

2615. Dielectric Constants of Water at Various Temperatures. A. C. Cuthbertson and O. Maass. *Am. Chem. Soc., J.* 52. *pp.* 483–489, *Feb.,* 1930.

A resonance method for the measurements of the dielectric constant of pure liquids is described, involving the use of a variable dielectric cell in which lead and end effects are eliminated and the dimensions of which can be altered over wide limits. The dielectric constants of ether, benzene, chlorobenzene and nitrobenzene were measured at 25° C. The dielectric constant of water was determined between 0° and 75° C. The step-by-step method used made it possible to make absolute determinations based on air as unity. The polarisability of water has been calculated from the dielectric constant data, and the futility of applying the Debye equation for this substance is pointed out. H. H. Ho.

2616. Dielectric Constants, Refractive Indices, and Ionising Power of Hydrogen Peroxide and its Aqueous Solutions. A. C. Cuthbertson and O. Maass. *Am. Chem. Soc., J.* 52. *pp.* 489–499, *Feb.*, 1930.

The dielectric constants of hydrogen peroxide and its aqueous solutions have been measured and a maximum shown to occur at a concentration of 35 % H_2O_2. The refractive indices of the above have also been measured over the whole range of concentration and at three wave-lengths. The molecular refractive power and dispersive power indicate that the structure cannot be represented by two hydroxyl oxygens, and it is suggested that the co-ordinate oxygen linkage which is given by Sugden's parachor has a definite atomic refractive power. The polarisability as calculated from the refractive indices has been shown to increase continuously with increased concentration of peroxide. A method has also been devised for measuring electric conductivities in hydrogen peroxide and its solutions. Potassium chloride solutions have been measured and the amount of dissociation shown to be nearly the same as in water. Acetic acid solutions were found to have far smaller conductivities than the corresponding solutions in water. The specific conductivity of pure hydrogen peroxide has been found to be less than 2×10^{-6}, and consequently it can only be very slightly dissociated. H. H. Ho.

2617. Dipole Measurements of Organic Molecules in Benzene Solution. O. Hassel and E. Naeshagen. *Zeits. f. phys. Chem.* 5. *Abt. B.* 6. *pp.* 441–445, *Feb.*, 1930.

This paper continues a general investigation of the dipole moments of organic substances [see Abstracts 278 and 1545 (1930)]. The electric moments of benzalacetone and of dibenzalacetone in benzene solution are both found to be $3 \cdot 3 \times 10^{-18}$ e.s.u. The increase with respect to acetone is ascribed to the effect of the benzol group upon the moment of the carbonyl group. The values for phthalaldehyde, isophthalaldehyde and terephthalaldehyde were found to be $10^{18}\mu = 4 \cdot 50$, $2 \cdot 86$ and $2 \cdot 35$ respectively. The first two values are in excellent agreement with the theory of the vector addition of the moments of disubstituted benzene derivatives, but for terephthalaldehyde, the moment should disappear as with para-compounds having two like groups. Other measurements are: furfurol ($10^{18}\mu = 3 \cdot 57$), nitrosobenzene ($10^{18}\mu = 3 \cdot 22$) and *p*-quinone ($\mu = 0$). H. H. Ho.

2618. Dipole Moments of the Butyl Halides. A. Parts. *Zeits. f. phys. Chem.* 7. *Abt. B.* 5. *pp.* 327–338, *April*, 1930.

The dipole moments of all the butyl chlorides, bromides and iodides have been calculated from the measurements of their dielectric constants in benzene solutions made by the suspension method at 20° C. and in part at 10°, 30° and 50° C. The tertiary compounds have the greatest moment of the 4 isomerides, and are followed by the secondary, normal, and iso-compounds respectively. The normal and iso-compounds show no difference in dipole moment. The moment does not change from the butyl chlorides to the bromides, whilst the normal and isobutyl iodides have an approximately $0 \cdot 1 \times 10^{-18}$ smaller moment in comparison with the corresponding chlorides and bromides. The temperature dependence of the polarisation between 10° and 50° C. is found to be in agreement for 6 compounds.

H. H. Ho.

2619. Variation in Ionisation in the Upper Atmosphere with Longitude. E. O. Hulbert. *Phys. Rev.* 35. *pp.* 240–247, *Feb.* 1, 1930.

Continuing a former paper [see Abstract 1550 (1930)] the present paper gives theoretical calculations of the changes in the ionisation in the upper atmosphere with longitude. The electrical conductivity of the upper atmosphere is about $1 \cdot 4 \times 10^{-5}$ at noon equinox at the equator and an order of magnitude less at night. The maximum density of electrons y_m varies with the latitude θ and longitude ψ, measured from noon equinox at the equator according to $y_m = 3 \cdot 14 \times 10^5 \cos\theta\ (0 \cdot 18 \sin\psi + \cos\psi)$ for the daylight hours. At night the expression is more complex. The values of y_m yield skip distances of short wireless waves roughly in accord with observation in the day but somewhat too great at night. The theory puts the shortest skip distance at 40 min. past noon, and observation in temperate zones gives 2 p.m.; the agreement is good, but not perfect.

AUTHOR.

2620. Variation of Residual Ionisation with Pressure at Different Altitudes and its Relation to Cosmic Radiation. W. F. G. Swann. *Frank. Inst., J.* 209. *pp.* 151–200, *Feb.*, 1930.

Measurements have been made of the residual ionisation in a closed steel vessel 1 in. thick, shielded by a 2-in. casing of lead, over a range of pressure from atmospheric to 1000 lbs. per sq. in. The measurements were made at the summit of Pike's Peak (alt. 14,000 ft.), at Colorado Springs (alt. 6000 ft.), and at New Haven (sea-level). The ionisation-pressure curves are used to obtain average relative values of the ionisation due to cosmic rays at the three altitudes concerned, corrections being applied for absorption by the steel sphere, the lead casing and the walls of surrounding buildings. It is found that the data for the three stations can be correlated by the assumption of a pair of frequencies in the original cosmic radiation; an infinite number of such pairs are possible. They are represented in graphical form. If the assumption of three frequencies in the cosmic radiation is made, it is possible in general to assign two of the frequencies and determine an infinite number of possibilities as regards the third, distributed over a definite range. The possibilities inherent in the assumption of three frequencies are presented in tabular form and discussed.

A. W.

CURRENT ELECTRICITY, MAGNETISM AND ELECTRO-MAGNETISM.

2621. Electrical Conductivity of Ruthenium. J. C. McLennan, J. F. Allen and J. O. Wilhelm. *Roy. Soc. Canada, Trans.* 23. *pp.* 283–286, *May*, 1929.

The resistance of a rod 15 mm. long and 2 mm. diameter was measured between temperatures 300° K. and 2° K. by means of a potentiometer of the

Cambridge Instrument Company. Below 4·2° K. the temperature of the boiling helium was calculated from the value of the measured pressure over the surface of the liquid. Below 2·3° K. the resistance decreased but slightly as the temperature was lowered, but at 2·04° K. the resistance suddenly and completely disappeared, the test-piece becoming superconducting. W. C. S. P.

2622. Electrical Conductivity of Certain Metals at Low Temperatures. J. C. McLennan, L. E. Howlett, J. O. Wilhelm. *Roy. Soc. Canada, Trans.* 23. *pp.* 287–306, *May,* 1929.

Temperature resistance measurements were made between room-temperature and 2·2° K. on the metals molybdenum, tantalum, hafnium, uranium, titanium, tungsten, magnesium, zirconium, niobium and lead deposited in thin films on zinc; also on misch metal and on the eutectic alloy of cadmium and antimony and on sodium-lead supposedly having the chemical composition Na_2Pb_5. Tantalum was found to become superconducting at 4·2° K. in agreement with Meissner. Niobium gave strong indications of becoming superconducting, but the rapid decrease in resistance observed with it at very low temperatures was taken to be due to presence of tantalum as an impurity. Misch metal showed quite a normal resistance curve for a substance that was a mixture of a number of elements. The alloy Na_2Pb_5 was found to become superconducting at the same temperature as pure lead. The eutectic alloy of cadmium and antimony was not found to be superconducting; its resistance curve showed a minimum at 165° K. and the resistance increased rapidly with decreasing temperatures down to 2·4° K. As a result of this work it becomes clear that it is not necessary to use metals in the state of extreme purity in order to exhibit with them the property of superconductivity. W. C. S. P.

2623. Measurements with the Aid of Liquid Helium. Part VI. Transition Curve to Superconductivity for Titanium. W. Meissner. *Zeits. f. Physik,* 60. 3–4. *pp.* 181–183, 1930.

The resistance of a single crystal of Ti was measured at temperatures from 273·2° Abs. downwards, and plotted as a function of the temperature and of the vapour pressure of helium. The specimen, though not absolutely pure, had a positive temperature-coefficient of resistance, and at 4° Abs. retained about 20 % of its resistance at 0° C. Below 1·28° Abs. the resistance dropped rapidly to a value in the neighbourhood of zero at 1·13° Abs. Real superconductivity was not quite attained. G. E. A.

2624. Superconductivity of Alloys. W. J. de Haas, E. v. Aubel and J. Voogd. *K. Akad. Amsterdam, Proc.* 33. 3. *pp.* 258–261, 1930. *Comm. No.* 208*a from the Phys. Lab., Leiden.*

The compound AuSn does not become superconducting at low temperatures, thus resembling Cu_3Sn and Cu_4Sn. The electrical resistivity of AuSn remains constant from 4·21° to 1·43° K. Hg_5Tl_2 becomes superconducting between 3·88° and 3·84° K. This transition point is a little lower than that of pure mercury and considerably higher than that of pure thallium. $PbTl_2$ becomes superconducting between 4·09 and 4·05° K., the transition point thus lying between those of pure lead and pure thallium. A silver-thallium alloy containing about 3 % silver becomes superconducting between 2·68° and 2·65° K., compared with a transition point in pure thallium of 2·37° K. [See Abstract 3398 (1929) and the following Abstract.] A. J. M.

2625. Influence of Magnetic Fields on Superconductors. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 33. 3. *pp.* 262–272, 1930. *Comm. No.* 208*b from the Phys. Lab., Leiden.*

The influence of a magnetic field on the electrical conductivity is determined for the intermetallic compounds $PbTl_2$, Sb_2Sn_3 and alloys of Pb–Bi, Pb–Sn–Bi and Pb–Sn–Bi–Cd. In all these cases, at temperatures below the transition temperature, increasing the intensity of the magnetic field to a certain value (magnetic threshold value) causes the superconductivity to disappear, and further increase of the magnetic intensity rapidly raises the resistivity until the normal value is recovered. The magnetic threshold value increases more rapidly as the temperature falls than in pure metals. The values of the magnetic field for which the resistance attains half its normal value [$H_{(\omega\frac{1}{2})}$] are as follows:—

Material.	$PbTl_2$.			Sb_2Sn_3			Pb–Bi eutectic.			
Temp. °K.	4·05	3·97	3·90	3·79	3·69	3·58	4·24	3·35	2·61	1·91
$H_{(\omega\frac{1}{2})}$ gauss ..	42	139	242	69	101	134	16,000	22,000	24,600	26,700

In the Pb–Bi alloys, increase of Bi content, within the limit of solid solubility of Bi in Pb, increases the magnetic threshold value. The Pb–Sn–Bi and Pb–Sn–Bi–Cd alloys give values very similar to those for the Pb–Bi eutectic. All the alloys containing Pb and Bi differ from $PbTl_2$ and Sb_2Sn_3 in showing a small hysteresis effect in the magnetic intensity-electrical resistivity curves. The results show that with a solenoid made of the saturated solid solution of Bi in Pb magnetic fields of 14,000 gauss at the boiling point of helium, and 19,000 gauss at 2° K., could be generated without development of heat. A. J. M.

2626. Minimum of Resistance at High Pressures. P. W. Bridgman. *Am. Acad. Proc.* 64. *pp.* 75–90, *Jan.*, 1930.

It has been found that at 30° C. the resistance of rubidium passes through a distinct minimum at 17,000 kg./cm.^{2}; with potassium the minimum seems to lie beyond 20,000 kg./cm.^{2}; extrapolating the curve between the first differences and the pressure the value 23,500 kg./cm.^{2} is arrived at for the pressure of the minimum resistance, the value of which can be estimated; the minimum for sodium probably lies near 28,000 kg./cm.^{2} and the value is estimated; the minimum point for cæsium had already been found at 4200 kg./cm.^{2}; lithium already increases in resistance with pressure at atmospheric pressure, so can have no minimum. If the pressure of the minimum is plotted against atomic number for Na, K, Rb and Cs a fairly smooth curve is obtained, the pressure of the minimum dropping at an accelerated rate towards Cs; relative resistance at the minimum plotted against atomic number gives a parabolic curve, with a deep minimum at potassium; in this connection attention is called to the very loose electronic structure of potassium, and its persistent compressibility at high pressures, though there does not appear to be a very close correlation between the effects. The possibility of the existence of the phenomenon in other metals is considered; it has already been observed in the case of barium. There is so far no theory to account for the facts. H. N. A.

2627. Resistance Changes in Stretched Nickel Wires. R. S. Bedi. *Phys. Zeits.* 31. *pp.* 180–182, *Feb.* 15, 1930.

Continues the investigation of the phenomena observed by Seth and

Anand [see Abstract 1663 (1929)], first making the measurements up to but never beyond the point where the electrical resistance has its minimum value, and back to zero stretching force; the values of the resistance for diminishing extension lie in all cases a little below those for increasing extension. Measurements were then made over cycles in which the wire was stretched step by step up to a point well above that at which the electrical resistance was a minimum, when it rose quickly to a value well above the original one; the stretching force was then gradually reduced to zero. As it fell the resistance first diminished to a minimum value well above the first minimum, and for still lower tensions rose until it was larger than the original starting value. When the load was gradually put on again the resistance first fell to a minimum value a little below the second minimum, and then rose again. Removal of the load gave a new minimum and a new final value of the resistance still higher up on the graph. No such effect was produced with copper, iron or steel wires. The peculiar behaviour of nickel is tentatively ascribed to an alteration in the atomic structure, which in some way increases the number of free electrons in the metal. H. N. A.

2628. Deviation from Ohm's Law in Intense Electric Fields. H. Margenaw. *Zeits. f. Physik*, 60. 3–4. *pp.* 234–236, 1930.

A previously found formula [see Abstract 3396 (1929)] is revised, with the result that the numerical agreement of theory and experiment is disturbed. The reasons for this are discussed. G. E. A.

2629. Theory of Change of Metallic Resistance in a Magnetic Field. N. H. Frank. *Zeits. f. Physik*, 60. 9–10. *pp.* 682–685, 1930.

So far there appear to be two different possibilities of explaining this effect by means of the properties of the electrons. The first has been used by Sommerfeld, who considers the Lorentz force acting on the electrons, that is, the diamagnetic action of the field; the other is that of Block, who considers the magnetic moments of the electrons, the original Fermi distribution of which is altered by a magnetic field. The author shows that Block has made a numerical error in estimating this paramagnetic effect, so that, instead of being much larger than Sommerfeld's diamagnetic effect as stated by Block, the effect of the spin of the electron can be neglected as compared with the diamagnetic action. Both these theories lead to a second power law, and neither agrees with Kapitza's new results for strong fields; no satisfactory explanation has so far been found for these, or for the normal effect with small fields. H. N. A.

2630. Peltier and Thomson Effects for Bismuth Crystals. H. D. Fagan and T. R. D. Collins. *Phys. Rev.* 35. *pp.* 421–427, *Feb.* 15, 1930.

The Peltier and Thomson effects are directly measured (the former against copper) in single crystal rods almost covering the entire orientation range. For the former effect the Voigt-Thomson symmetry relation is definitely not substantiated, while for the latter the data do not provide an adequate test, though it appears likely that there is a deviation here also. The following values are found: at a temperature of 27° C., $\pi(\| \text{vs.} \perp) = 13 \cdot 8$, $\pi(45° \text{vs.} \perp) = 8 \cdot 6$ microvolts; at a temperature of 48·5° C., $\sigma \| - \sigma \perp = 43$, $\sigma_{45} - \sigma \perp = 26 \cdot 5$ microvolts/° C. These values are all in fair agreement with values deduced from thermal e.m.f. temperature data of the writers and of previous observers. AUTHORS.

2631. Early Stages of Electric Sparks. E. O. Lawrence and F. G. Dunnington. *Phys. Rev.* 35. *pp.* 396–407, *Feb.* 15, 1930.

Photographs of the early stages of electric sparks with exposure times down to 4×10^{-8} sec. were obtained using the Kerr-cell electro-optical shutter. The speed of spread of luminosity from Zn, Cd and Mg electrodes was observed and recorded, as also the width of the spark, doublet lines of these metals. At extremely short intervals of time after the beginning of a spark the discharge is confined to a filament of anodal cross-section 5×10^{-4} cm.^{2}, which broadens out fourfold at the kathode. The discharge current density is estimated at $1 \cdot 7 \times 10^6$ amperes/cm.^{2} On the basis of Stark effect consequences the average interionic field is calculated to be 10^6 volts/cm., thus indicating that the average separation of the ions was $3 \cdot 8 \times 10^{-7}$ cm. and that 1/3 of the molecules in the discharge path were ionised. Four methods employed for estimation of spark temperature lead to values of the order of 10,000° Abs. Thermal ionisation is, therefore, a prominent feature of such discharges. S. G. B.

2632. Passage of High-Frequency Currents Through Discharges in Gases. B. Klarfeld. *Zeits. f. Physik,* 60. 5–6. *pp.* 379–386, 1930.

Uses a Braun tube to obtain oscillograms of h.f. currents passed through discharges in different gases. The phase of the current is found to lag behind that of the tension at the electrodes. When the frequency is increased the resistance of the gas in which the continuous discharge is taking place increases. The results obtained agree with those previously described, for which a thermoelement was used. H. N. A.

2633. A Spark Lamp. H. Boas. *Zeits. f. Physik,* 60. 9–10. *pp.* 690–701, 1930.

Describes a new arrangement for producing luminous sparks by means of condenser discharges. By using a large mica condenser with very small self-induction in the circuit the frequency of the characteristic vibrations can be made large, and the brightness of the spark lines greatly increased. The electrodes are fed together by means of a small motor, which is started and stopped by means of an electrostatic relay, so that the distance between them and the flow of current through the spark gap remain unaltered when they burn away. It is found advantageous to blow away the aureole of heated air which surrounds the spark, and an arrangement is provided for doing this either with a blast of air or with some other suitable gas. H. N. A.

2634. Obstructed Glow Discharge. A. Güntherschulze. *Zeits. f. Physik,* 61. 1–2. *pp.* 1–14, 1930.

An investigation of the effect on the anomalous kathode potential drop, of bringing a plate (anode) near to the kathode, so that the discharge is obstructed. The anode consisted of a large, flat disc, which was raised or lowered by a wire attached to a horizontal rod working in a ground-glass joint. The distance between the anode and kathode discs was made small compared with their diameters [see Abstract 1841 (1927)]. In the gases H_2, O_2 and He, the kathode drop decreased, went through a minimum, and then rose steeply as the distance between the plates was reduced. In neon the kathode drop increased, right from the start, as the distance between the plates was reduced, at first slowly and then rapidly. At the same time the thickness of the kathode space increased, and in such a way that it was proportional to the kathode drop. Results for N_2 and for argon were intermediate between H_2, O_2 and He on the one hand, and neon on the other. It was possible by bringing the anode sufficiently near to the kathode almost to obliterate the negative glow. At higher gas pressures the glow disappears when the kathode drop is 600 volts, and it was possible to investigate a glow-discharge quite free of negative glow between 600 and 3000 volts. A. C. M.

2635. Ions Produced by Discharges at Liquid Surfaces. J. J. Nolan and J. G. O'Keeffe. *Roy. Irish Acad., Proc.* 39*a*. 3. *pp*. 21–30, *Dec.*, 1930.

The method adopted for the experiments was practically identical with the "electric wind" method of Chattock. The discharge took place from the end of a fine glass tube to a polished metal ring. The results of numerous experiments (which are tabulated) lead the authors to the following conclusions: (1) Chattock's method can be applied to measure the mobilities of the ions concerned in the discharge from liquid surfaces. (2) The mobilities found for these ions show that they are of the same character as the ordinary small ions produced by discharge at a metal point or by the ionising radiations. (3) Confirmation has been obtained of Tyndall and Phillips' observation that in air saturated with *n*-butyl and *n*-amyl alcohols at ordinary temperatures, the mobility of the positive ion is greater than that of the negative. J. G. H. B.

2636. Excitation of Mercury by Impact of Slow Sodium Ions. B. Kirschstein. *Zeits. f. Physik*, 60. 3–4. *pp*. 184–195, 1930.

Sodium ions from a Kunsman glowing anode [see Abstracts 156 and 2176 (1926)] were accelerated over a distance of 2 mm. towards a narrow-mesh gauze, and entered a field-free space within which they collided with atoms of mercury. The light emitted by the atoms was examined spectroscopically through a quartz window. Excitation of the line 2537 was noted at a minimum of 35 volts. At 50 volts the number of collisions effective in producing light is of the order of 1 in 10^5. G. E. A.

2637. Ionisation of Dicyanine by Slow Electrons. K. E. Dorsch and H. Kallmann. *Zeits. f. Physik*, 60. 5–6. *pp*. 376–378, 1930.

The products resulting from the collisions of slow-moving electrons with molecules of $(CN)_2$ were investigated, using the method of positive-ray analysis [see Abstract 1778 (1929)]. The ions were present in the ratios $C^+ : C_2^+ : (CN)^+ : (CN)_2^+ = 1{\cdot}5 : 1 : 2 : 12$. A. C. M.

2638. Concentration of Positive Ions in Mercury-Neon Low-Voltage Arcs. W. de Groot. *Zeits. f. Physik*, 60. 9–10. *pp*. 617–623, 1930.

Former experiments on the subject were continued. Two low-voltage arc lamps, which were as nearly equal as possible, provided with plane quartz windows were employed; the oxide spirals were so arranged that a ray of light could pass through both windows and through the interior of the spiral. The image of the spiral of lamp (1) was formed on that of lamp (2) by means of a quartz lens, adjusting to the resonance line 1942 Å. ($2^2P_{1/2} - 1^2S_{1/2}$HgII). The image of the spiral of lamp (1) was formed on the slit of a spectrograph or a monochrometer. The spectra of lamp (1), of lamp (2), and of the two lamps together were then measured through suitable sheets of gauze. Two methods of measurement of the intensities were employed, one photographic, the other photoelectric; they give results which, at least in order of magnitude, are equal, and give a concentration of from 1 to 2 × 10^{12} ions per cc. Since the fine structure of line 1942 Å. is unknown, this is a minimal value for the concentration. H. N. A.

2639. Elementary Processes in Ion and Electron Collisions. H. Kallmann and B. Rosen. *Zeits. f. Physik*, 61. 1–2. *pp*. 61–86, 1930.

Different ions generated by slow-electron collisions, in the ionisation chamber of the mass spectrograph, were passed into the magnetic field chamber which contained a gas or mixture of gases whose absorption or deionising effect was being tested. The ions He^+, Ne^+, A^+, N_2^+, N^+, O_2^+, O^+, C^+, CO^+ and CO_2^+, and the absorbing gases helium, neon, argon, nitrogen, oxygen, carbon monoxide, carbon dioxide, ammonia and mercury vapour, were investigated. The general method was to measure the relative intensities of the several ion types for different pressures in the absorption chamber, keeping the pressure in the ionisation chamber constant. The results show that high selection absorption occurs when the energy liberated in neutralising the ion by adding an electron is approximately equal to the ionisation energy of the absorbing gas. The quantum mechanics of the neutralisation process is discussed. W. S. S.

2640. Application of High Potentials to Vacuum Tubes. M. A. Tuve, G. Breit and L. R. Hafstad. *Phys. Rev.* 35. *pp*. 66–71, *Jan*. 1, 1930.

A brief progress report is made on the results so far obtained in the development of vacuum tubes to which the very high voltages produced by Tesla coils (greater than 10^6 volts) can be applied. One cascade tube has been constructed which withstood repeatedly a voltage of 1,400,000 volts, and others have been used at lower voltages. This method, originally developed by Coolidge, gives promise of being suitable for voltages of several million, and eventually perhaps even higher. No effort has been made so far to use these tubes with a definite and controlled emission, since experience has shown that single-section tubes operated at several hundred kilovolts have approximately the same voltage limitation with or without hot kathodes. The chief difficulty with very high-voltage tubes is that of preventing the uncontrollable (cold-kathode) emission which limits the voltage which can be applied. An electrodeless tube which withstood 1,000,000 volts is briefly described. [See Abstract 2308 (1930).] AUTHORS.

2641. Static Field Strength for Discharge with Plate Electrodes. W. Rogowski. *Zeits. f. Physik*, 60. 11–12. *pp*. 776–781, 1930.

Deduces Schumann's discharge condition on the supposition that space charge is the determining element in discharge, and that ionisation by positive ions, as assumed by Townsend, may be excluded. E. E. F. d'A.

2642. Emission of Electrons and Positive Ions from Filaments of Tungsten, Molybdenum and Tantalum in Potassium Vapour. Edith Meyer. *Ann. d. Physik*, 4. 3. *pp*. 357–386, *Feb*. 8, 1930.

The form of curves relating to ionic emission in these cases is essentially the same as that obtained by other workers in the case of cæsium vapour. For the same filament temperature, however, it was found that the electron emission reaches a maximum for a certain pressure of potassium vapour. G. E. B.

2643. Emission of Positive Ions from Tungsten and Molybdenum. L. P. Smith. *Phys. Rev.* 35. *pp.* 381–395, *Feb.* 15, 1930.

It was sought to determine the following points: (1) the nature of the ions emitted at various temperatures; (2) the temperature variation of the positive ion current; (3) the theory of positive ion emission with regard to where and how the ions are formed; (4) the positive ion work function for these metals; (5) whether the work function, determined by experiment, checks with that calculated by a simple cyclic process involving the thermionic work function, the ionising potential, and the latent heat of evaporation of the metal. The mass spectrum for tungsten and molybdenum filaments taken at moderate temperatures (1700° to 2000° K.) has shown that the emitted ions consist of sodium, the two isotopes of potassium and aluminium. At high temperatures these impurities disappear, and, finally, both tungsten and molybdenum filaments yield positive ions of their own metal. The latter results confirm a report by Wahlin. The temperature variation of the positive ion current at high temperature yields a value of 6·55 volts for the positive ion work function of tungsten and 6·09 volts for that of molybdenum. These values disagree widely from the values 10·88 volts and 9·26 volts calculated from the simple cyclic process mentioned above. This suggests that the ions are formed as a by-product of an irreversible recrystallisation of the metal. Theoretical considerations show that the ions are emitted from the metal and are not formed after a neutral atom evaporates. AUTHOR.

2644. Action of Light in Thermionic Phenomena. R. Deaglio. *Comptes Rendus,* 190. *pp.* 299–300, *Feb.* 3, 1930. *N. Cimento,* 7. *pp.* 69–79, *Feb.,* 1930.

Case, Merritt, Ives and others have observed an effect of illumination upon thermionic currents. The author investigates whether this action is a temperature effect or a true photoelectric effect. The light from a carbon arc was concentrated on the middle of a glowing filament by a glass lens. When the thermoelectronic current is far from saturation, it is increased by illumination by about 0·01 microampere. Now a rise of temperature due to the light would not account for more than 1 % of this increase, which must, therefore, be regarded as almost purely photoelectric. When there is saturation, the increase is of the same order of magnitude as the temperature effect. E. E. F. d'A.

2645. Photo Conductivity in Liquid Dielectrics. W. H. Eller. *J.O.S.A.* 20. *pp.* 71–80, *Feb.,* 1930.

Describes work done on the change in resistance of liquid dielectrics when subjected to ultra-violet radiation, the minimum wave-length employed being about 2300 Å. The liquids were organic, and mainly of the paraffin type. It is shown that the ionisation produced by ultra-violet light has a threshold value corresponding very nearly to the absorption limit, and increasing in wave-length as the higher members of the series are reached. Recombination was also studied, and it was found that the theoretical law $dn/dt = -an^2$ is fulfilled. The slowness of recombination suggests heavy ions, of low mobility, such as would result from molecular disruption. G. E. B.

2646. New Photoelectric Cell. B. Lange. *Phys. Zeits.* 31. *pp.* 139–140, *Feb.* 1, 1930.

The efficiency of the cell is greatly enhanced, in the sense that a greater portion of the light-energy is converted into available electrical energy, by the device of having the sensitive electrode in contact with a uni-polar semi-conductor. By this means the energy required to extract an electron is much less than in the usual case where it proceeds into a vacuum.

J. H. A.

2647. Forms of Gasfilled Photoelectric Cells: Their Properties and Calibration. J. Kunz and V. E. Shelford. *Rev. Sci. Instruments*, 1. *pp.* 106–117, *Feb.*, 1930.

An account of experiments with photoelectric cells for measuring sunlight and for biological research. Gasfilled (hydride) cells were tested and used in outdoor work for a considerable period. The authors recommend the collapsed-sphere form of cell, with the sensitive surface on the convex portion of the interior, as showing the least variation with angle of incidence of the radiation. For standardisation they employed 1000-watt Mazda daylight lamps, and on clear days sunlight reduced by rotating sector discs. They recommend that for each cell the limits of stability should be determined, and in use a margin of at least 25 % be allowed. If used for continuous recording, exposed to the sun, water cooling should be adopted, a small jet of water should be directed towards the sensitised part to prevent glowing.

E. G.

2648. Spatial Distribution of Photoelectrons. S. E. Szczeniowski. *Phys. Rev.* 35. *pp.* 347–374, *Feb.* 15, 1930.

The perturbation of a hydrogen-like atom by a plane polarised electromagnetic wave is considered on the basis of Dirac's equation, and perturbed wave-functions are obtained. These functions lead by a method similar to that used by Sommerfeld in his *Wellenmechanisches Ergänzungsband* to a formula for the spatial distribution of the photoelectrons. To the first approximation this formula differs from that given by a factor 5/9 in the second term. The angle between the average direction of the emission of the photoelectrons and the electric vector of the incident wave appears, therefore, to be equal to $h\nu/cmv$ instead of the value $(9/5)$ $(h\nu/cmv)$ given. The factor 5/9 follows from the consideration of the normalising factors for the spherical harmonics, which were not introduced by Sommerfeld. A second approximation has also been obtained showing the influence of electron spin. This approximation differs from that obtained by Carrelli, in that the spin and some other terms not considered by Carrelli and also the factor 5/9 appear.

AUTHOR.

2649. Influence of NO on the Photoelectric Sensitivity of Potassium. R. Fleischer and H. Teichmann. *Zeits. f. Physik*, 60. 5–6. *pp.* 317–319, 1930.

The authors find that the presence of NO in a photoelectric cell using potassium causes the sensitivity to be very greatly increased, with a maximum sensitivity at 3650 Å., thus allowing of the construction of a photoelectric cell with high sensitivity for the ultra-violet.

A. C. M.

2650. Photo Effect in the K-Shell. A. Sommerfeld and G. Schur. *Ann. d. Physik*, 4. 4. *pp.* 409–432, *Feb.* 24, 1930.

The authors calculate the photo effect for light of short wave-lengths. For that case the formula for the distribution function must contain an additional term, and it is displaced forward in the direction of the light. This displacement is double the displacement due to radiation pressure alone. The calculation is carried out for the K-shell of atoms. [See also following Abstract.] E. E. F. d'A.

2651. Photo Effect in the L-Shell. G. Schur. *Ann. d. Physik,* 4. 4. *pp.* 433–442, *Feb.* 24, 1930.

The author calculates by the method described [see preceding Abstract] the distribution of the photoelectrons of the L-shell. E. E. F. d'A.

2652. Non-Stationary Treatment of the Photoelectric Effect. H. Bethe. *Ann. d. Physik,* 4. 4. *pp.* 443–449, *Feb.* 24, 1930.

It is shown that in the wave-mechanics theory of the photoelectric effect the Dirac method of variation of the constants leads to a complete description in space and time of the process of electron emission. It appears that one obtains, as in the stationary method, only a diverging wave, the physically meaningless converging wave automatically vanishing. W. S. S.

2653. Refraction of Short Electric Waves in Certain Electrolytes. K. Zakrzewski and T. Nayder. *Acad. Polonaise Sci. et Lettres, Bull.* 1–2*a*. *pp.* 30–41, *Jan.–Feb.*, 1930. *In French.*

Apparatus resembling a spectrometer was constructed to measure the deviation of 12-cm. waves after passing through a prism containing a solution of NaCl or $CuSO_4$. Damped waves were employed. These were focussed by the use of a parabolic reflector, a second reflector being used round the detector. The solutions used included 1·5, 2 and 3 % solutions of $CuSO_4$ and a 0·3 % solution of NaCl. In no case was any perceptible difference found between the refractive index of the solution and that of pure water. [See Abstract 2573 (1929).] A. W.

2654. Absorption of Trains of Waves in a Dielectric. G. Kreutzer. *Zeits. f. Physik,* 60. 11–12. *pp.* 825–844, 1930.

The absorption of a limited sine-form electromagnetic wave-train when penetrating into a dispersing absorbing material is investigated. As found by many others, the absorption coefficient deviates noticeably from the value of classical optics. The character of this deviation and the dependence of the absorption on the depth of penetration and on the frequency and period of the waves are investigated. An exponential selective absorption is found which is zero for frequencies of 0 and ∞. The absorption for a given depth is smaller than that for the classical theory for frequencies near to the free values for the molecular resonators, but larger for very large or very small frequencies. The numerical integration for ethyl alcohol and for different values of the parameter is performed, and generally confirms the theoretical results. The connection of these results with those of the theoretical work of Brillouin on the dispersion of wave-trains and some experimental work of Colley and others is indicated. R. S. R.

2655. Electrical Peculiarities of Galena Crystal. F. Regler. *Phys. Zeits.* 31. *pp.* 168–172, *Feb.* 15, 1930.

In connection with the hypotheses on which the theory of the contact detector and current conduction in high ohmic resistances and solid insulators is based, the author has carried out experiments with galena crystals and has shown the contraction or extension of the crystal under the influence of an electric field. The conductivity increases with the contact pressure. Departures from Ohm's law arise through variable pressures, and the varying transition resistances thereby caused between electrode material and crystal. With a loose contact, and with corresponding adjustment, the contact pressure, and with it the conductivity, may be higher in one direction of the current than the other, and so the conduction in such a system appears unipolar. J. J. S.

2656. Law Connecting Various Characteristics of Ferromagnetic Crystals. N. S. Akulov. *Zeits. f. Physik*, 59. 3–4. *pp*. 254–264, 1930.

The formulæ are developed for the calculation of magnetostriction, internal energy density, the surface $(\sigma - \sigma_0)$ between the magnetisation curves on the H.J_p diagram, and the normal component J_n of the magnetisation for any chosen intensity and direction of it. Besides these simple expressions, the result of the extension of the author's work in a previous paper [see Abstract 333 (1930)], the relationship between $(\sigma - \sigma_0)$ and the normal component, as also the relation between the intensity of magnetisation and the external field strength, is developed, which relationships are valid for directions of magnetisation selected at will. All the formulæ as derived above are shown to be in agreement with experimental results, and, finally, on the basis of these expressions, a law is laid down which connects together the whole of the known ferromagnetic characteristics of the crystals with each other. The law of magnetic anisotropy of iron and nickel in single crystals may be formulated as follows: If a crystal is magnetised to a known intensity in the direction of its main axis, and then is magnetised to the same intensity in other directions chosen at will other than the main axis, the differences between the resulting elongations per unit length of the crystal $(\delta l/l)$, parallel to the direction of magnetisation, and the differences between the variations in resistance $(\delta R/R)$ of the surface $(\sigma - \sigma_0)$ between corresponding magnetisation curves in the H.J_p diagram, *i.e.*, the alteration of the internal energy density, are proportional and can be determined by means of the general formula:

$$\frac{1}{n}\left|\left(\frac{\delta l}{l}\right)_s - \left(\frac{\delta l}{l}\right)_0\right| = \frac{1}{\rho}\left|\left(\frac{\delta R}{R}\right)_s - \left(\frac{\delta R}{R}\right)_0\right| = \frac{1}{K}(\sigma_s - \sigma_0) = 2(s_1^2 s_2^2 + s_2^2 s_3^2 + s_3^2 s_1^2).$$

S. G. B.

2657. Magnetic Moments of Atomic Nuclei. E. Fermi. *Zeits. f. Physik*, 60. 5–6. *pp*. 320–333, 1930.

The magnetic moments of the nuclei of sodium and cæsium atoms are deduced from the hyperfine structure of the spectra of these elements. Cæsium [see Abstract 837 (1929)] has lines which consist of two components having a separation of about 0·3 wave-number, while the sodium lines as observed by Schuler are similarly constituted, the separation, however, being only 0·06 wave-number. The cæsium lines all have approximately the same separation of their components, and it is attributed to a hyperfine structure of the ground-term $6^2S_{\frac{1}{2}}$. In this paper the author calculates the fine structure to be expected for an alkali atom. He employs the Dirac theory to obtain the *s*-terms, and leaves the value of *k* open (*k* = mechanical moment of the nucleus in units of $h/2\pi$), while he uses the simpler Pauli theory, with *k* put = $\frac{1}{2}$, to get the less important *p*-terms. The calculation shows that the separation of the *s*-term components is approximately ten times that of the *p*-terms, so that the lines will be doublets to a first approximation. The actual value of the atomic magnetic moment depends upon the value of *k* for the *s*-terms; consequently the values are given for $k = \frac{1}{2}$, 1, $\frac{3}{2}$, and infinity. From the relative intensities of the components, *k* is probably 1 for sodium. This makes the atomic magnetic moment to be $\mu_0/670$, where $\mu_0 = 1$ Bohr magneton. If k also is 1 for cæsium, the corresponding value is $\mu_0/1460$. In a note added in the proof, the results are appended of the calculation of the p-terms using the more rigorous Dirac theory, previously only used for the s-terms. A. C. M.

2658. Influence of Grain Size on Remanence of Pure Iron. O. v. Auwers and G. J. Sizoo. *Zeits. f. Physik,* 60. 7–8. *pp.* 576–580, 1930.

The non-agreement between the two authors as to their values [see Abstract 1672 (1929)] for the influence of granular size on the remanence is conceded as being due to experimental error, created by unavoidable unreliability in material and uncertainty of experimental measurement. Thus, values showing discrepancy were obtained individually. The present note clears up the matter, and shows the true significance of the influence of granular size. S. G. B.

2659. Problem of the Two Curie Points. R. Forrer. *J. de Physique et le Radium,* 1. *pp.* 49–64, *Feb.,* 1930.

The ferromagnetic Curie point, θ_f, is defined by the disappearance of the spontaneous or of the remanent magnetism. The paramagnetic Curie point, θ_p, is defined by the Curie-Weiss law: $\chi(T - \theta) = C$. In general, $\theta_p - \theta_f$ is positive, and of the order of 20°. Further, remanent magnetism and coercive force do not vanish at the same temperature, and at θ_f the coercive force still has a finite value. Also extrapolation of H_c gives a point θ_k which practically coincides with θ_p. At temperatures below θ_p, reversal of magnetic moment requires a finite field; above θ_p, the reversal is unresisted. If θ_p is below θ_f, free reversal at temperatures above θ_p prevents spontaneous magnetisation; hence, there is a sudden drop in magnetisation at θ_p. The case of the ferrocobalts confirms these hypotheses. It is concluded that θ_p and θ_f are expressions of two different mechanisms, and that to obtain spontaneous magnetisation in a body having magnetic moment two conditions are necessary, namely, spontaneous orientation and hysteresis. Ferromagnetism, therefore, exists only at temperatures below the two Curie points. G. E. A.

2660. Diamagnetism of Halogen Ions. G. Foëx. *Comptes Rendus,* 190. *pp.* 481–483, *Feb.* 24, 1930.

The ionic susceptibilities of the halogens have been calculated as 8/7ths of the atomic susceptibilities deduced from Pascal's results. The values ($x \times 10^6$) thus determined (Cl 23·0, Br 34·9 and I 51·0) agree within the limits of experimental error with those of Weiss [see Abstract 2301 (1930)]. The method assumes that the orbits of the seven valency electrons of the halogen atom are not affected by the arrival of the eighth, and that this last has a similar orbit; also that the susceptibility is not altered by the union of the two atoms to form a molecule. It is thus in conflict with the hypothesis of any orbit encircling the whole molecule. C. A. S.

2661. Diamagnetism of Electrons in Metals. F. Bitter. *Nat. Acad. Sci., Proc.* 16. *pp.* 95–98, *Feb.,* 1930.

By taking into account the wave structure of the electron, a formula for the diamagnetic susceptibility of free electrons is obtained, having the same form as the classical formula, but, instead of the mean free path λ there appears $a/4$, where a is the grating constant of the cubic lattice under consideration. Accurate measurements on lithium are required to supply a reliable check to the theory given here. G. E. A.

2662. Electromagnetic Equations of Maxwell-Hertz. A. Tonolo. *Accad. Lincei, Atti*, 10. *pp.* 646–648, *Dec.* 15, 1929.

An outline of the author's method of integration of these equations is given. J. J. S.

2663. Heaviside's Operational Method. D. P. Dalzell. *Phys. Soc., Proc.* 42. *pp.* 75–79; *Disc.*, 79–81, *Feb.* 15, 1930.

The author describes a method of treatment of Heaviside's operational calculus which involves unrestricted use of complex integration as employed by Bromwich, and concludes that the theory of integration provides a complete explanation of all the aspects of Heaviside's method of solving differential equations. AUTHOR.

2664. Reflecting Power and Polarisation by Reflection for Electron Waves. W. Alexandrow. *Zeits. f. Physik*, 60. 5–6. *pp.* 387–394, 1930.

Expressions for plane electron waves satisfying the Dirac equations, in two media of constant electrostatic potentials O and U respectively, are fitted for a plane boundary at which the potential jump of amount U occurs. The laws of reflection and refraction of electron waves are deduced, and rigorous formulæ for the reflected amplitudes and the reflecting power are derived, which resemble the Fresnel optical laws. The notion of polarisation of electron waves is introduced as a linear coupling of the amplitudes of the four Dirac wave functions, and it is shown that the phenomenon of polarisation by reflection fails for electron waves. For slow electrons and for perpendicular incidence, the formula for the reflecting power takes precisely the Fresnel form $\left(\frac{n-1}{n+1}\right)^2$, where $n = \frac{\lambda}{\lambda'}$, λ and λ' being the de Broglie wave-lengths in the two media. W. S. S.

2665. Reflection of Electron Waves by Thin Films. W. Alexandrow. *Zeits. f. Physik*, 60. 5–6. *pp.* 395–401, 1930.

The wave-functions for plane waves representing electrons being given, it is shown how these can be fitted to the boundary conditions appropriate to a thin sheet. The sheet is defined as a region of constant electrical potential which is known. The amplitudes of the reflected waves in terms of the incident waves are given, as well as the ratio of the intensities of the incident and reflected waves. The corresponding formulæ for electromagnetic waves traversing thin sheets are obtained as limiting cases of those developed in this paper. G. C. McV.

APPARATUS AND INSTRUMENTS.

2666. Method of Eliminating Magnetic Disturbance of High-Sensitivity Galvanometers. A. B. D. Cassie. *Journ. Sci. Instruments*, 7. *pp.* 21–22, *Jan.*, 1930.

Light reflected from two mirrors oscillating with equal amplitudes and frequency may, by the method described, be projected on a scale to give an image at rest, and this may be employed to eliminate changes in zero of certain galvanometers. AUTHOR.

2667. Sensitivity of a Galvanometer as a Function of its Resistance. H. B. Brooks. *Bureau of Standards, J. of Research*, 4. *pp.* 297–312, *Feb.*, 1930.

The condition for maximum deflection of a galvanometer (resistance G), connected to an external circuit of resistance R and containing a given e.m.f., was given by Maxwell as $G/R = D/(D + 2t)$ when the thickness of the insulation t is constant. Ayrton and Perry, assuming t to vary with the diameter D of the wire, obtained the relationship $G = R$. The author verifies these relationships, but shows that the sensitivity function is very flat in the vicinity of the maximum. He shows that, apart from considerations of damping, the user has a wide range of choice of galvanometer resistance, with relatively small loss of sensitivity, and can, in fact, sometimes obtain much better sensitivity with moving-coil galvanometers (when critical damping is considered) by departing from the theoretical optimum value of resistance. The constructional limitations and those related to damping which must be considered in applying the conclusions of the paper are outlined, and the practical advantages of the facts brought out are briefly summarised. W. C. S. P.

2668. Illumination Arrangements for the String Galvanometer. A. Köhler. *Zeits. f. Instrumentenk.* 50. *pp.* 146–155, *Feb.*, 1930.

A discussion of the optical requirements for the accurate use of the string galvanometer, and a description of some illumination arrangements by which these are more or less completely fulfilled. J. J. S.

2669. Gyro Compasses for Gunfire Control. S. G. Brown. *Journ. Sci. Instruments*, 7. *pp.* 40–49, *Feb.*, 1930.

An explanation of the " Gun-Directional Compass." The worst error against which a gyro compass has to contend is the " North steaming error," due to the angular motion impressed upon the gyro when the ship is steaming over the curved surface of the ocean. The requirements of gunfire are considered. The gyroscopic direction apparatus should maintain a fixed direction in space, its departure from the true north direction should be accurately known, and the motion of the ship should have no action whatsoever upon the compass. A description of the " Static " gyro compass is given. A means is given whereby each of the ships composing a fleet can set their Static gyro compasses exactly to that on the flagship. A Static gyro compass fitted with transmission and repeater gear has also been devised for aeroplanes in order that they may direct gunfire. T. C. H.

2670. Twentieth Annual Exhibition of the Physical and Optical Societies. *Journ. Sci. Instruments*, 7. *pp.* 57–62 *and pp.* 64–68, *Feb.*, 1930.

Notes on Exhibits: " Commercial Electrical Instruments," by **A. C. Jolley**; " Laboratory Electrical Instruments," by **E. H. Rayner**; " Wireless Apparatus," by **R. L. Smith-Rose.**

2671. Device for Protecting Water-Cooled Mercury-Vapour Lamps. L. Piatti. *Phys. Zeits.* 31. *pp.* 182–184, *Feb.* 15, 1930.

Two switches are provided, in each of which the ends of two wires dip into mercury. One of them breaks the lamp circuit when the water supply pipe ceases to function, the other if the waste pipe is choked. Both are actuated by variations of pressure in the waste pipe. H. N. A.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2672. Biological Action of Secondary β-Radiation from Buried Needles or Tubes Containing Radium. J. C. Mottram. *Brit. J. of Radiology*, 3. *pp.* 62–68, *Feb.*, 1930.

The difference between the incident secondary β-radiation from platinum and mica when radiated with γ-radiation from radium was detected biologically by effects upon the growth of Jensen's rat sarcoma after *in vitro* radiation. A similar difference was detected photographically. With regard to emergent secondary β-radiation it was concluded that when radium is heavily screened with heavy metals there is no advantage in using paper to cut off the secondary β-radiation, and that when platinum needles or tubes containing radium are buried in living tissues, secondary β-radiation will play a part in the effects obtained. W. V. M.

2673. British Institute of Radiology Exhibition, 1929. G. E. Bell. *Brit. J. of Radiology*, 3. *pp.* 76–81, *Feb.*, 1930.

A survey of the main exhibits at the Exhibition, with special reference to new developments and modern tendencies. Mainly concerns equipment for medical purposes. G. E. B.

2674. Factors Influencing the Speed of Intensifying Screens. F. E. Swindells. *J.O.S.A.* 20. *pp.* 51–61, *Feb.*, 1930.

The speed of intensifying screens was measured at three arbitrary densities by a sensitometric method. The screen factor was found to increase with shortened development time; to increase with increase of tube potential; to be independent of the tube current from 2 to 35 mA.; to be independent of the target film distance from 0·5 to 2·5 m.; to increase as more filtering medium was interposed between the tube and screens; and to vary considerably with the photographic emulsion used. The increase with increasing potential is explained as the effect of the varying energy losses of X-rays of different wave-lengths when passing through the front screen, and also by the different relative abilities of X-rays of different wave-lengths to excite fluorescence, and to expose silver bromide. The variation of the speed factors with different emulsions is due to different relative sensitivity of the screens to X-rays and to the fluorescent light from the screens. AUTHOR.

2675. Infra-Red Transmission of the Flesh. C. H. Cartwright. *J.O.S.A.* 20. *pp.* 81–84, *Feb.*, 1930.

The spectral energy of light transmitted through the cheek was tested photographically in the region of $\lambda 0 \cdot 86\mu$, and also by a spectrometer throughout the whole spectrum. A very sensitive vacuum thermocouple was used. The photographs of the spectrum showed 14 % transmission of $\lambda 0 \cdot 86\mu$ through the cheek. The cheek transmitted a maximum of 20 % at $\lambda 1 \cdot 15\mu$, and the water in the body cut off the longer wave-lengths. The spectral energy transmitted by bacon fat was found to be similar to that of the cheek; however, it transmitted nearly five times as much energy. The ordinary incandescent electric light with filters to cut out the visible and infra-red beyond $\lambda 1 \cdot 4\mu$ is ideal for deep penetration of light into the body. AUTHOR.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2676. Effect of One Salt on the Solubility of Another in Ethyl Alcohol Solution. Part IV. F. S. Hawkins and J. R. Partington. *Faraday Soc., Trans.* 26. *pp.* 78–86, *Feb.*, 1930.

The changes of solubility caused by the addition of lithium perchlorate to saturated solutions of sodium iodide in ethyl alcohol can be satisfactorily represented by the equation $-\log \mathrm{APR} = 3\alpha(\sqrt{2\mu} - \sqrt{2\mu_0}) + \beta c$, which is due to Brönsted, in which the activity-product ratio, APR, is used and the first term represents the effect due to interionic attraction, while the second is usually attributed to the salting-out action of the ions of the added salt. The results are not in agreement with a later equation proposed by Brönsted. [For Part III see Abstract 623 (1929).]
C. O. B.

2677. Solubilities and Conductivities of Inorganic and Organic Compounds in Liquid Hydrofluoric Acid. K. Fredenhagen and G. Cadenbach. *Zeits. f. phys. Chem.* 146. *Abt. A.* 3–4. *pp.* 245–280, *Feb.*, 1930.

The solubilities of a number of inorganic materials in pure hydrofluoric acid were determined, and the results indicated that the previously published results must be revised. The solubilities were very different from the solubilities of the same materials in water. The chlorides, bromides and iodides were either insoluble or, like the alkali and earth-alkali halogen salts, they were decomposed with the formation of fluorides and the evolution of halogen hydride. The halogen hydrides themselves were neither soluble, nor did they form ions in liquid hydrofluoric acid. Cyanides and azides behaved similarly. The determinations of the conductivities showed that in solutions of different compounds, both inorganic and organic, the only anion was the fluorine ion, but that kations existed in addition to the metal ion. The results were shown to be in harmony with the theory of the specific solution force of Fredenhagen. F. J. B.

2678. Structure of Surface Films. Part XIV. Some Esters of Fatty Acids. Evidence of Flexibility in Long Chains. Part XV. Amines. N. K. Adam. *Roy. Soc., Proc.* 126. *pp.* 366–372, *and* 526–541, *Feb.* 3, 1930.

Part XIV gives (area per molecule)/(lateral compression) curves for films of the *n*-propyl, *n*-butyl, *n*-octyl and *n*-hexadecyl esters of palmitic acid, $C_{15}H_{31}COOR$. Condensed films with the normal area of 20·5 Å.^{2} at no compression were obtained where R contains not more than 4 carbon atoms, though with increasing difficulty as the length of the alkyl chain increases. In these cases the alkyl chain must continue the direction of the acidic chain into the water. Octyl palmitate forms a film of the "liquid expanded" type with area of about 85 Å.^{2} at no compression. It is concluded that here the molecule is anchored to the water by the carboxyl group with both acidic and alkyl chains pointing upwards and oscillating, a conclusion strengthened by the almost precisely similar behaviour of glycol dilaurate $C_2H_4(COOC_{11}H_{23})_2$. *n*-propyl and *n*-butyl palmitates appear to behave similarly at higher temperatures. *n*-hexadecyl palmitate gives a solid film of area 41 Å^2., showing that in this case the acidic and alkyl chains are practically close-packed and pointing vertically upwards. These results clearly demonstrate the flexibility of these chains. Part XV gives similar curves for films of the amines n-$C_nH_{2n+1}NH_2$ (n = 14, 16, 17, 18 and 20) on solutions (usually buffered) of from $N/10$ alkali to $N/10$ acid. To spread the films the amine hydrochloride dissolved in alcohol-benzene (4 : 10) was generally used. On alkaline solutions the condensed films are solid and of the "close-packed chain" type with area for no compression 20·5 Å.^{2} per molecule. The expanded films vary, but usually show considerable lateral adhesion between the molecules. On the acidic side the pH value has little effect, but much depends on the nature of the acid radicle present (acetic, benzene-sulphonic, hydrochloric, phosphoric, phthalic or sulphuric). The films evidently consist of salts of the amines therewith, the structures of which are very various. In most cases the expanded films are "gaseous." The results disagree with Lyons and Rideal's theory of interlocking chains [see Abstracts 3223 (1929) and 2319 (1930).] C. A. S.

2679. Viscosity Formula for Binary Mixtures. Part V. T. Ishikawa. *Chem. Soc. Japan, Bull.* 5. *pp.* 47–54, *Feb.*, 1930. *In English.*

The author criticised the formula of Einstein and the modification proposed by Hatschek for calculating viscosities. Kendall's cube root equation was tried on certain binary mixtures, and, although the results were good, it was considered that this formula was only a further interpolation formula, applicable to ideal solutions. A viscosity formula, developed by the author in a previous paper [see Abstract 1710 (1930)], was modified to allow of the degree of association being taken into account. This formula was tested on solutions of naphthalene in benzene, naphthalene in toluene, diphenyl in benzene, and in toluene at 25° C., and on naphthalene in benzene and in toluene, carbon tetrachloride, carbon bisulphide at 20°, 40° and 60° C. for the benzene and toluene solutions. The results were extremely satisfactory. F. J. B.

2680. Soap Films and Colloidal Behaviour. A. S. C. Lawrence. *J. Phys. Chem.* 34. *pp.* 263–272, *Feb.*, 1930.

Soap films are credited with a sandwich structure consisting of a variable amount of liquid between two surface layers, and both these layers and the liquid are supposed to be colloidal in structure. The author (formerly working with Dewar) shows that neither assumption is necessary. The static surface tension of soap solutions is low, about one-third that of water; the dynamic surface tension (observed by Rayleigh with continuously renewed surfaces) is much greater. Thinned soap films show interference colours, and finally turn silvery white (100 $\mu\mu$) and black; but there are different orders of black: first, 6 $\mu\mu$; second, 12 $\mu\mu$; fifth, 30 $\mu\mu$. Dewar's highly stable films were of the second order. The first and other blacks are much less stable. The rare formation of a first-order black from the second-order black film involves the rupture of one surface and coalescence of the interior liquid on the remaining surface. Neither the surface layers of a soap film nor the films as such are colloidal in structure. Saponin gives colloidal films; when the air is sucked out of a saponin bubble it loses its shape, and is drawn out into a V with a liquid drop at the bottom; there is a real surface skin. The molecule of a soap solution consists of a chain of CH_3 and CH_2 groups, with a CO.OH group at the end. Only the latter is soluble in water; but in the acids of the $C_nH_{2n}O_2$

type (fatty acids) the carboxyl group can carry the whole chain into solution as long as there are not more than 5 kations; then colloidal properties begin to develop. In alcohol both the hydrocarbon and the carboxyl groups are soluble, and no colloidal particles are formed; in benzene only the hydrocarbon end is soluble. The formation of a stable soap film requires two conditions: the lowering of the surface tension of water by the formation of an oriented adsorbed layer of molecularly-dispersed solute, which, secondly, should have an effective lateral cohesive strength greater than the disruptive force of the residual surface tension. H. B.

2681. Structure of Gelatin Sols and Gels. Part I. Viscosity of Gelatin Solutions. S. E. Sheppard and R. C. Houck. *Kodak Research Lab., Comm. No.* 395. *J. Phys. Chem.* 34. *pp.* 273–298, *Feb.*, 1930.

There is no critical transition temperature of sol-form to gel-form, but only a temperature zone of transition from sol-state to gel-state. The particular question investigated is whether a definite temperature exists at which the viscosity becomes independent of temperature, and, if so, whether the invariant temperature be independent of *p*H, concentration, etc. The materials were a good calf-gelatin and two lots of Eastman de-ashed gelatin prepared to the standard specifications of the Am. Chem. Soc. The temperature of dissolution should be as high as compatible with slight chemical breakdown. There is an initial fall of viscosity which is greater when the solution (for an operating temperature of 40° C.) is made up at 40° than when made up at 52°; both rapidly approach a constant rate of viscosity fall, not a constant viscosity. The data of the paper concern mostly solutions of 7 %, whilst 3 % is more usual. Comparative viscosity values can only be obtained with gelatin sols of definite *p*H of the same age at constant temperature. Such solutions kept below a certain temperature show a steady increase of apparent viscosity, and at higher temperature, a steady fall of viscosity with time. A rise followed by a fall in viscosity has been ascribed to bacterial attack, but takes place also in presence of antiseptics. The steady fall is due to hydrolysis. The viscosity-age curves for different *p*H are all humped, but the fluidity (reciprocal of viscosity) time curves are straight or broken lines; the latter would meet at *p*H = 6, but there is an intercept (horizontal) for *p*H = 5 − 8. Gelatin consists of markedly asymmetrical, flat or elongated molecules, capable of orientation under stress. While hydrolysis involves reduction of water-binding power in gelatin, with decrease of viscosity, the conversion of collagen (hide-powder) into gelatin is a hydrolysis of the opposite effect. Most commercial gelatins contain some incompletely peptised collagen particles. The molecules of gelatin and collagen are fundamentally identical, but differ as to the degree of association and orientation. H. B.

2682. Physical Conditions Affecting the Setting of Gelatin and Theory of Gel Formation. Winnifred B. Pleass. *Roy. Soc., Proc.* 126. *pp.* 406–426, *Feb.* 3, 1930.

Setting of gelatin is accompanied by evolution, and melting by absorption of heat. Curves connecting H-ion concentration with that of gelatin necessary for gelation resemble those for water absorption of gelatin at varying *p*H values and those for the rate of ice crystallisation from gels of varying H-ion concentration. At any temperature the proportion of

V.3
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gelatin initially setting has a minimum at *p*H 5·0. At 18° C., or below, the setting curves show maxima at *p*H 2·3–2·6 and a decrease between 2·3 and 1·2; the curve rises slowly from *p*H 5 to 10. Rise in temperature decreases the gelling power, more markedly above than below 18° C. Between 25° and 0° C. gelatin gels of *p*H 4·5–5·5 are turbid and exhibit synæresis. The results obtained are interpreted by postulating the change on cooling from a solution of gelatin in water to one of water in gelatin, with formation of a framework of hydrated gelatin. Turbidity is regarded as the indication of heterogeneity, one phase being hydrated gelatin and the other a dilute solution of water in gelatin. Presence of acid or alkali causes reduction in the hydration of the gelatin aggregates accompanied by increase in the free water and decrease in the strength of the gel.

T. H. P.

2683. Swelling of Gelatin in Acids. E. Sauer and E. Kleverkaus.

Kolloid. Zeits. 50. *pp.* 130–141, *Feb.*, 1930.

The swelling of gelatin in acids has been considered to be dependent upon the nature or concentration of the acid or simply upon the H-ion concentration. In order to eliminate sources of error in settling this question, the authors suppressed the simultaneous formation of sols by working at rather low temperature (12° C.) and keeping the gelatin and liquid in uninterrupted motion (centrifugal); equilibrium conditions were then obtained in pure water within an hour and in acids in three hours. In the centrifugal apparatus the maximum volume could accurately be determined and the acid concentration be kept constant. The experiments were made with powdered gelatin in water and acids (hydrochloric, sulphuric, nitric, acetic, chloroacetic, propionic, naphthalenesulphonic) at varying concentrations and temperatures. The liquid was continuously renewed. In strong acids the maximum swelling occurs at low concentrations, in weak acids at high concentrations. The proportion of acid retained by the gelatin increased with the acid concentration. The *p*H value of the solution was always a little lower than that of the gel (2·4 against 2·9), whilst the opposite held for the total acid concentrations. The degree of dissociation of the acid bound by the gel would, therefore, be lower than that of the external liquid.

H. B.

2684. Molecular Constitution of Liquid and Solid Intermetallic Solutions. F. M. Jeffery.

Faraday Soc., Trans. 26. *pp.* 86–89, *Feb.*, 1930.

The molecular constitution of certain intermetallic solutions, both liquid and solid, has been studied by the application of the equation $\log(1-n') - \log(1-n) = \frac{\lambda}{R\theta} - \frac{\lambda}{R\theta_0}$, in which n' is the molal fraction of the solute in the solid solution, n is the molal fraction of the solute in the liquid solution. Results have been calculated for solutions of tin in lead, lead in tin and cadmium in tin, the liquidus and solidus for each system having been determined by an electrical resistance method. Tin dissolves in lead as such, similarly lead in tin; at temperatures in the neighbourhood of the liquidus the molecule of each metal is monatomic. There is no evidence of the existence of an intermetallic compound. These statements apply both to the liquid and solid solutions. Similar statements apply to a certain range of solutions of cadmium in tin, both liquid and solid.

C. O. B.

2685. Rate of Dissolution of Metals. M. Tarlé. *Chem. Soc. Japan, Bull.* 5. *pp.* 57–64, *Feb.*, 1930. *In German.*

Referring to Ericson-Aurén and to Centnerszwer [see Abstract 3188 (1929)], the author describes experiments made with rods of zinc, 5 mm. diameter, chemically pure, and magnesium, less pure, at 25°C. in acids (HCl, organic, acetic, dioxybenzoic, etc.). Sometimes a spiral of stout platinum wire was screwed into the rod; hydrogen then appeared at the Pt, not the Mg. That the rate of dissolution depends also upon the concentration may be due to the formation of salts. This and the addition to the acids of neutral salts ($ZnCl_2$, $MgCl_2$, KCl, etc.) accelerated the dissolution of magnesium much more than that of zinc, the anions acting in the order $Br' > I' > Cl' > SO_4'' > CH_3.COO'$. The effect is probably connected with the solubility of the hydroxide formed by the reaction of the metal with water. H. B.

2686. Kinetics of Recrystallisation. R. Karnop and G. Sachs. *Zeits. f. Physik*, 60. 7–8. *pp.* 464–480, 1930.

The experiments described deal with the influence of degree of stretch and of temperature on the initiation of recrystallisation of copper rods with a tapered portion. The stretched rods were heated for a certain time so that they recrystallised up to a certain place, the diminution in section being then determined. There seems to be no "recrystallisation temperature" below which recrystallisation no longer occurs, although at low temperatures recrystallisation is extremely slow. Similarly, there appears to be no critical degree of stretch. Experiments made to determine the progress with time of nucleus-formation and of crystal-growth in the recrystallisation of stretched (10 %) aluminium rods gave inconclusive results, but showed that the linear velocity of growth during recrystallisation is independent of the time and that new nuclei are continually being formed during recrystallisation. The number of nuclei and the velocity of growth increase markedly with the degree of stretch, especially when this is small and the velocity of growth is low. T. H. P.

2687. Chemical Forces and Molecular Attraction. J. Frenkel and N. Semenoff. *Zeits. f. Physik*, 59. 9–10. *pp.* 638–639, 1930.

It is pointed out that the idea [see Polanyi, *Zeits. f. Elektrochem.* 35. p. 561, 1929] that chemical forces, owing to the rapidity with which they decrease with increasing distance from an atom or molecule, play no part in the van der Waals forces of molecular attraction, is unsound. F. J. W.

2688. Relationship Between van der Waals Forces and Homopolar Valence Forces. R. Eisenschitz and F. London. *Zeits. f. Physik*, 60. 7–8. *pp.* 491–527, 1930.

In this mathematical paper a systematic disturbance process has been developed which comprises the homopolar and the van der Waals forces in a unitary connection, and contains the earlier investigations on chemical union as a first approximation. This method is applied to the determination of the van der Waals constants for atomic hydrogen. H. H. Ho.

2689. Propagation of Flame in Gaseous Explosions. W. M. Thornton. *Phil. Mag.* 9. *pp.* 260–272, *Feb.*, 1930.

The view that the conditions for the transmission of flame by an exchange of radiation between members of a complex are all present in the wave-front is held reasonable. The momentary excess of rotational energy is the characteristic feature of molecular combination in gaseous explosion Previous and allied work is discussed and the practical issues are described. A metal sheath 80 cm. long concentrically surrounded the middle portion of a glass tube of diameter 3 cm. and length 1 m. A metal rod 8 mm. in diameter formed at the centre of the tube the inner pole, and between it and the sheath a voltage of 10,000 V was maintained (unidirectional). The flame was observed through a space in the sheath 5 mm. wide. The mixture under test was ignited in the exhausted tube by a spark at the bottom. No difference of velocity of the flame was noted with and without the strongest fields, working with a 9·5 % methane/air mixture, the lower end of the tube being opened after ignition and the mixture pressure atmospheric. Dixon's results were assumed confirmed, but repetition with weaker mixtures, transverse electric fields were found to accelerate markedly the speed of the flame. The results given in tabular form (means of 20 determinations) are conclusive proof that at all pressures, at and below atmospheric, flame travels faster in a transverse electric field. Discussing activation by radiation from the flame and effect of tube diameter, Burgess and Wheeler's results indicate that velocity of uniform motion of flame in tubes is proportional to the cube root of the tube diameter; further evidence indicates that activation by which flame travels is radiation according to Stefan's law. Thus, facts relevant to flame transmission in open tubes are: (1) not retarded by magnetic fields, (2) not retarded by electric fields, (3) velocity of uniform motion is proportional to fourth power of the temperature. Suggested conclusion indicates sole cause of pioneering activation from flame as being electromagnetic radiation. Explanation is afforded of so-called " steam lines " in radiation from explosion of undried gases or steady flames. May be caused by spin induced by combining collisions of H_2 and O_2 molecules leading to formation of steam. Energy radiated from a flame in a given mixture is apparently a nearly constant proportion of the heat of combination; spectroscopic evidence indicates spin in wave-front; pressure is less than accountable by thermal change, hence mechanics consideration essential. These considerations reconcile all facts. An inflammable mixture at point of ignition is a highly sensitive detector of radiation. Compression and ignition are reviewed, and results obtained utilised as explanation of high explosion velocities in coal mines and galleries with an end enclosed. S. G. B.

2690. Theory of Flame Motion. P. J. Daniell. *Roy. Soc., Proc.* 126. *pp.* 393–405, *Feb.* 3, 1930.

The observed motion of a flame is compounded of the motion of the gas and of the transmission of flame through the gas. The author considers the velocity of the flame relative to unburnt gas at some distance from the flame, this being termed the natural velocity V. For the purpose of mathematical analysis it is more convenient to consider a uniform endless tube with the flame, taken as a disc, at rest and with a steady motion of gas. Attention being restricted to motions slow in comparison with the velocity of sound in the gas, and certain assumptions being made, a formula is deduced for V, cooling being neglected. Cooling introduces a term which lowers the velocity, and there is a certain minimum positive velocity below which propagation is impossible. Certain experimental investigations are suggested, among them comparative measurements for gaseous mixtures varying essentially only in the temperature attained in the flame, thermal conductivity, rate of reaction, specific heat or density. T. H. P.

2691. Extinction of Methane Flames by Water Vapour. H. F. Coward and J. J. Gleadall. *Chem. Soc., J. pp.* 243–248, *Feb.*, 1930.

The limits of inflammability of methane in air are narrowed by the progressive addition of an inert gas to the air. Data for the effect of carbon dioxide, nitrogen, argon and helium have been already published [see Abstract 2411 (1926)] and the present investigation supplies a series of results obtained with water vapour. The conclusion is drawn that in the relative extinctive effects on methane flames of diluent gases which take no important part in the flame reactions, the chief factor is the heat capacity of the diluent, but that helium stands in an exceptional position by virtue of its high thermal conductivity. Other factors have very little influence. Carbon tetrachloride, although it undergoes extensive reaction in the flame of a methane-air mixture, falls into line with the other diluent gases. H. H. Ho.

2692. Ionisation in Fuel Vapours During Slow Combustion in Air. F. Gill. *Faraday Soc., Trans.* 26. *pp.* 49–61, *Feb.*, 1930.

A report of an investigation to measure directly the ionisation currents in fuel vapours under approximately atmospheric pressure at temperatures up to 400° C. The apparatus, technique, experimental results and a theoretical discussion are appended. The experiments show conclusively that in several vapours which undergo slow combustion in air with phosphorescence at temperatures as low as 150° C. there is no measurable ionisation at temperatures up to 400° C. The minimum theoretical ionisation current measurable by the electrometer is determined experimentally, and hence it is shown that the number of ions possibly present is of the maximum order of 60 per c.c. Since at N.T.P. the number of molecules per c.c. is about 3×10^{19}, any ionisation present may be assumed to be incidental and not the cause of high chemical activity. Lead tetraethyl, amyl nitrite, benzene and other organic substances of similar character, which had a marked effect on the phosphorescence in CS_2, hexane, and other vapours with air, have little or no power to assist ionisation, or create it. Until self-ignition occurs or is approached, hydrogen-air mixtures are not ionised. The catalytic effect and action of nitrogen peroxide on the combustion of hydrogen is not capable of explanation electrically, and experiments with these two gases in the absence of air show that ionisation is not responsible for the resulting chemical changes. S. G. B.

2693. Time Course of Heat Effects in Rapid Chemical Changes. Parts I and II. F. J. W. Roughton. *Roy. Soc., Proc.* 126. *pp.* 439–486, *Feb.* 3, 1930.

Part I describes apparatus and methods. The method of Hartridge and Roughton [*ibid.* 104. p. 376, 1923] for following the velocity of rapid chemical reactions has been extended to the measurement of the amount of heat liberated in rapid reactions within periods of 0·01 sec. or less from the commencement. For this purpose an extensive test has been made of the physical sources of error involved in the measurement of temperature of rapidly moving fluids by means of thermo-junctions, and an accuracy of 0·001° C. has been attained. Other tests have shown the method to be valid to an accuracy of 0·0002° C. for determining the temperature gradients in a reacting fluid as it travels down the observation tube, when the reaction under study is slow enough to "occupy" more than the first 2 to 3 cm. of the observation tube. Part II investigates some reactions of acids, bases, amino-acids and proteins. By the methods of Part I it is found that: (1) The total heat of neutralisation of most of the usual acids and bases (strong and weak) is liberated within a period of less than 0·01 sec. (2) The reactions of carbonic acid with alkali, and of bicarbonate with acid, however, involve heat changes which under appropriate conditions are spread out over periods of considerably more than 0·01 sec. The buffering reactions of glycine and the blood proteins are also discussed including their physiological and physico-chemical implications. H. H. Ho.

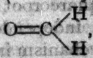
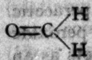
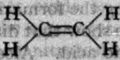
2694. Combustion Limits of Vapour-Air Mixtures Under Reduced Pressures. E. Berl and E. Hartmann. *Zeits. f. phys. Chem.* 146. *Abt. A.* 3–4. *pp.* 281–293, *Feb.*, 1930.

Data are given for the explosive limits of mixtures of air with ether, acetone, hexane, cyclohexane and benzene vapours. Under decreasing pressures, the explosion limits contract until below a minimum pressure, a reaction no longer takes place. The magnitude of the critical ignition pressure is dependent on the igniting strength. With increasing facility of oxidation, hydrocarbons exhibit a widening of combustion limits and a decrease of critical ignition pressure. By admixture of nitrogen, which on account of its high specific heat absorbs a large part of the heat of reaction, the combustible region is much reduced and the critical ignition pressure raised. Full experimental details are given. H. H. Ho.

2695. Thermal Ozone Decomposition. H. J. Schumacher and G. Sprenger. *Zeits. f. phys. Chem.* 6. *Abt. B.* 6. *pp.* 446–458, *Feb.*, 1930.

It is shown that the monomolecular ozone decomposition which generally accompanies the bimolecular reaction is of an heterogeneous nature. Bimolecular ozone decomposition is regarded as a bimolecular reaction in which the energy of activation consists essentially of the inner energy of colliding molecules. H. H. Ho.

2696. Quantum Theory of Double Chemical Bonds. E. Hückel. *Zeits. f. Physik*, 60. 7–8. *pp.* 423–456, 1930.

Considers the double bonds C=C and C=N, and their connection with cis- and trans-isomers in one case and syn- and anti-isomers in the other. The bond in each case has a certain stability against a twisting of the molecule, and the first part of the paper studies the problem from the point of view of the ordinary structural formulæ, and comes to the conclusion that a complete explanation of the phenomena cannot be obtained with classical conceptions as to the active forces. Starts with the electronic theory of the oxygen structure as developed by Lennard-Jones, and makes use of his symbols. Shows that in O_2 the two 2 $p\sigma$ electrons of Lennard-Jones have eigen functions which are antisymmetrical in spin, and correspond to an ordinary spin valency. The relations between the two 2 $p\pi$ electrons are worked out on the wave theory. It is shown that the ground state of the oxygen molecule, which depends on them, is a paramagnetic $^3\Sigma$ state. The double bond due to the two π electrons, with opposite, orbital impulse moment, but with spin moments in the same direction, can be regarded as an impulse valency (l valency) in Heitler's sense. O = O is next imagined as changed into , and then into O=N—H,  and , by separating out H atoms from the

O nuclei. Shows that the C=C and the O=C double bonds are due to ordinary spin valency, due to the two σ electrons, and a further valency of another character. The bond is of a different nature from the double bond of the O_2 molecule, and it is to this difference that the existence of substituents is due. The theory accounts for the diamagnetic character of these substances, also for the fact that isomers can be changed from one form into the other by ultra-violet light. H. N. A.

2697. Chemical Effects of X-Rays and Energy Relations Involved. G. L. Clark and Lucy W. Pickett. *Am. Chem. Soc., J.* 52. *pp.* 465–479, *Feb.*, 1930.

The effect of X-rays has been studied on (1) the oxidation of ferrous to ferric sulphate, (2) the polymerisation of anthracene to dianthracene, (3) a solution of iodine in benzene, (4) a mixture of iodine acetone and water, (5) the inversion of cane sugar in the presence of lead nitrate, (6) the condensation of aldehydes and ketones, (7) aqueous solutions of potassium iodide, (8) aqueous solutions of potassium nitrate, (9) solutions of colloidal lead, (10) the coagulation of colloidal clay. In the first five cases irradiation with X-rays had no effect. The condensation of aldehydes and ketones was considerably increased by X-rays, although the corresponding condensations between aldehydes were hardly influenced, if at all. The photolysis of potassium iodide and nitrate in the absence of oxygen is in both cases proportional to the dosage of the radiation. It is concluded that the presence of hydrogen peroxide is not essential for photolytic oxidation. In the case of the potassium nitrate solutions one molecule decomposes for every five ion pairs formed. The coagulation of colloidal clay by X-rays is found to be a function of the amount of protein impurity present. F. J. W.

2698. Absorption and Chemical Reactions in Atomic Rays. M. Lańcucki. *Acad. Polonaise Sci. et Lettres, Bull.* 1–2A. *pp.* 20–29, *Jan.-Feb.*, 1930. *In French.*

It was found that the absorption of nitrogen during the passage of electric discharges in a lamp with electrodes of iron or aluminium is closely connected with the pulverisation of these metals. The total quantity of iron pulverised combines chemically with the total quantity of nitrogen absorbed. The pulverisation of iron kathodes, and probably also of those of aluminium, tungsten and other metals, depends on the temperature of the kathode. The effect on the absorption of nitrogen of raising the temperature of the kathode is the same as that of a corresponding increase of voltage. It was found that the compound of iron and nitrogen obtained by pulverisation of the kathode has no ferromagnetic properties. A. W.

2699. Photochemical Interaction of Acetaldehyde and Oxygen. E. J. Bowen and E. L. Tietz. *Chem. Soc., J. pp.* 234–243, *Feb.*, 1930.

A peroxide is formed when gaseous, liquid or dissolved acetaldehyde is exposed in presence of oxygen to ultra-violet light, and the reaction has been examined in different spectral regions. In the liquid and the dissolved state the peroxide is also formed in the dark. The rate of reaction is found to be proportional to the square root of the light intensity and to the aldehyde concentration, but independent of the oxygen concentration, facts explained by a chain mechanism involving the formation of peracetic acid as the first product. Reasons are given to show that diacetyl peroxide is formed by further reactions of the peracetic acid. Alcohol acts as an inhibitor when added to hexane solutions of aldehyde, and the rate becomes directly proportional to the light intensity instead of to its square root. Anti-knock substances do not all act as inhibitors of the photochemical reaction between acetaldehyde and oxygen. H. H. Ho.

2700. Photochemical Transformations and Photovoltaic Cells. S. Schlivitch. *Comptes Rendus,* 190. *pp.* 302–303, *Feb.* 3, 1930.

In a previous paper [see Abstract 1660 (1930)] the photovoltaic cell, Pt/solution of uranium salt/Pt, was investigated. The e.m.f. of this cell was determined at different pressures and *in vacuo.* The investigation was continued to determine whether the photochemical changes shown by other methods were determinable by the new method. It was found that when a solution of uranium salt in pure water was exposed to light for the second or third time the e.m.f. obtained after illumination was less than that obtained after the first exposure. The effects of oxidation on the chemical changes produced by light and producing the e.m.f. were investigated, and it was shown that the dissolved oxygen directly influenced the magnitude of the e.m.f. F. J. B.

2701. Potential of Lead-Lead Ion. M. Randall and J. Y. Cann. *Am. Chem. Soc., J.* 52. *pp.* 589–592, *Feb.,* 1930.

The potential of the lead-lead ion electrode is determined by measurements of the lead amalgam-lead nitrate electrode, combined through flowing junctions with a silver-silver chloride electrode. The standard potential of lead ion is found to be 0·1203 V., and the free energy of formation to be — 5551 cal. at 25° C. A. J. M.

2702. Effect of Hydrogen-Ion Concentration on Electrode Potential of Iron. A. L. McAulay and G. L. White. *Chem. Soc., J. pp.* 194–199, *Feb.,* 1930.

The determination of the electrode potentials of pure iron in air-free solutions of various *p*H values, and containing potassium chloride or phosphate, led to standard and reproducible results. These results were considered as a foundation for work of a practical nature, in which the conditions were more complicated. Curves showing the relation between *p*H and equilibrium potential divide into two straight lines of different slope. An attempt was made to explain the curves. Solutions not air-free led to curves showing a very marked discontinuity. F. J. B.

2703. Becquerel Effect. Part III. I. Lifschitz and S. B. Hooghoudt. *Zeits. f. phys. Chem.* 146. *Abt. A.* 2. *pp.* 145–172, *Feb.,* 1930.

Continued researches [see Abstract 2639 (1929)] on the distinctions between effect I (surface effect, light falling on the electrode) and effect II (volume effect, light acting upon the electrolyte). Reviewing the methods of measurements, the authors decide in favour of e.m.f. determinations in open chains of the type: electrode/electrolyte/unpolarised electrode, in the dark and in the light. Such quantitative measurements are, however, impossible in case II, and not always possible in case I, because the potentials are not reproducible, especially in the dark. They, therefore, use polarised electrodes in closed chains, a potentiometer of Feussner, accumulator, commutator, five contacts and three electrodes. The light electrode (platinum, copper oxide or sulphide) is mounted in a quartz tube and water cooled; the electrolyte is stirred by gas; the unpolarised electrode (Pb or Hg in their nitrates) and normal electrode are in cells separated by intermediate vessels from the other cells. The fraction of E_p representing the potential change of the light electrode per 100 mV. change of E_p is called the polarisation rise; it is larger in the light than in the dark because the internal resistance is smaller in the light. The electrolytes tested are the sulphates and chlorides of copper and uranyl. The difference π between the dark and light e.m.f. values depends upon the nature of the electrolyte, temperature and intensity and wave-length of the light, but is independent of the chain resistances, choice of the dark electrode (unpolarisable), the polarisation potential, etc. But it is doubtful whether a pure Becquerel effect II can be measured with electrodes of platinum or gold, etc. Carborundum seems to be a suitable electrode material which would not be influenced by the displacements of oxidation and reduction potentials. H. B.

2704. Theory of Viscosity of Solutions of Strong Electrolytes. B. N. Finkelstein. *Phys. Zeits.* 31. *pp.* 165–167, *Feb.* 15, 1930.

For binary electrolytes dissolved in dipole liquids, the influence of the relaxation of the dipole molecule of the solvent on the viscosity of the solvent is given by an expression which, in conjunction with that obtained by Falkenhagen and Dole [see Abstract 1273 (1930)], results in the formula $(\eta_\gamma - \eta_0)/\eta_0 = C_1\sqrt{\gamma} + C_2\gamma$ for the dependency of the relative viscosity of electrolytic solutions on the concentration, η_γ and η_0 being the respective viscosity coefficients for molar concentrations γ and 0. Thus, this dependency is to be attributed to two fundamentally different causes, the deformation of the ionic atmosphere investigated by Falkenhagen and Dole being an effect of the first order. A new and simpler calculation of the action of the relaxation of the dipole molecules of the solvent on the viscosity of the solution is given. T. H. P.

2705. Effect of Superposing Alternating Currents on the Electrolytic Oxidation of Aluminium. S. Setoh and A. Miyata. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 227. *pp.* 268–274, *Feb.* 20, 1930. *In English.*

The superposition of a suitable a.c. in the electrolytic oxidation of aluminium resulted in a reduction of the electric energy required to obtain a given thickness of the oxide film. The film so obtained had a greater resistance to corrosion by hydrochloric acid than the film produced by d.c. alone. Treatment of the article which was coated with the oxide film by steam converted it into a water-proof film and enormously increased the chemical resistance to corrosion. The increase was considered due to some reducing agent in the film. F. J. B.

2706. Electrodeposition of Nickel. Part I. Effect of pH and Various Buffering Agents. Presence of Oxygen in the Deposits. J. B. O'Sullivan. *Faraday Soc., Trans.* 26. *pp.* 89–93; *Disc.,* 94. *Feb.,* 1930.

The deposition of nickel from solutions containing 24 gm. of nickel sulphate in 100 cc., to which were added the different buffering agents, was investigated. It was found that the deposits obtained from buffered solutions became smoother and finer grained as the *p*H of the bath was raised. It was suggested that this was due to colloidal nickel hydroxide or basic salt formed in the kathode film. Small amounts of oxygen found in the nickel deposits supported this view. F. J. B.